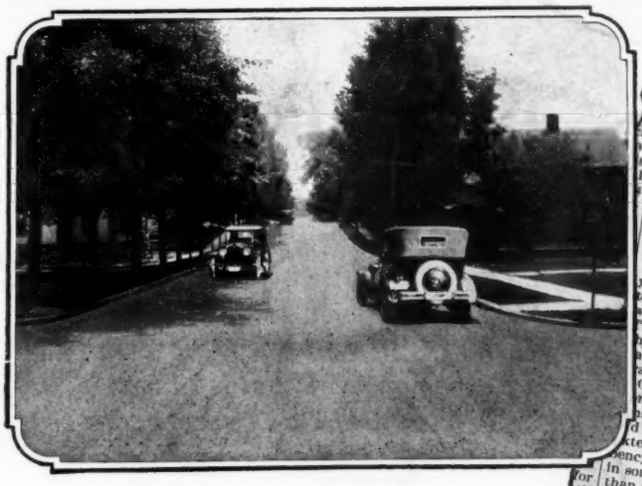
JUL 24 1925

PUBLIC WORKS

CITY COUNTY STATE



Built in 1909, this typical Tarvia street is still in perfect condition after 16 years of service.

Tax-Payers Reelect Road Commissioner

Voters Repeat Performance of Last Election—Keep Commissioner Edwards in Office

By an overwhelming vote of confidence yesterday, J. E. Edwards was reelected to the office of Road Commissioner, a post which he has held continuously since 1909. The absence of all opposition testifies to the complete endorsement by the taxpayers of the Road Commissioner's program.

Old residents can recall when Commissioner Edwards, advocating a comprehensive policy of road construction, repair and maintenance, first took office in 1909, sixteen years ago. Prior to his encumbency the streets of the community were in sorry shape. Yet with considerably less than a liberal appropriation, Mr. Edwards was able to accomplish wonders.

Main Street was his first objective. So far gone was the surface of this main thoroughfare, it was decided to completely ...one work was done in the summer

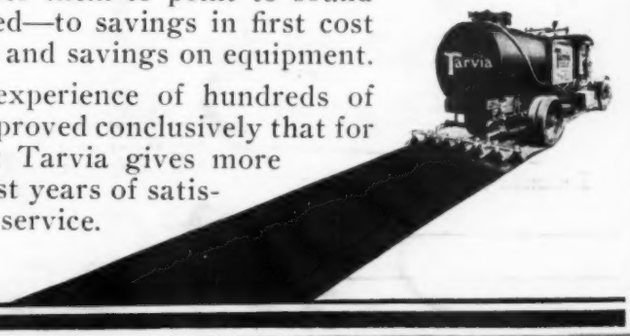
The Road Official's record is "out in the open"—

Tarvia Service Chapter VII

AS all public officials know, no official record is more completely "out in the open" than that of the road commissioner. If old roads are not well kept up, if new construction is not going forward, taxpayers soon begin to stir things up.

Quite natural that so many road commissioners lean toward a Tarvia program. For Tarvia enables them to point to sound economies effected—to savings in first cost and maintenance and savings on equipment.

In brief, the experience of hundreds of road officials has proved conclusively that for the money spent Tarvia gives more miles and the most years of satisfactory highway service.



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JULY, 1925

Patrol Graders with Lost Motion Left Out

LOST MOTION may well be called the curse of Patrol Graders, so the elimination of all lost motion from the 1925 Little Western, Westford, and Western No. 1 Patrol Graders marks a real achievement in the construction of maintenance equipment.

What is Meant by "Lost Motion"

"Lost motion" is that play at the connecting points of the blade control mechanism which makes it possible for the blade to ride over a hard, high spot or drop down into a low one. This makes fine work out of the question; but it was a necessary evil with which patrolmen were forced to contend until Western Engineers turned their attention to the problem, with the results we will now describe.

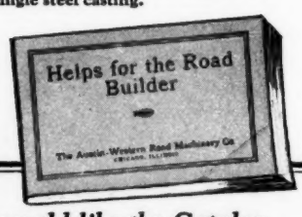
How Western Engineers have Eliminated Lost Motion

The blade control mechanism is of the worm and gear type, self-locking in any position. Both worm and gear are accurately machined cut steel. The worm and the flange to which the hand wheel is bolted are a single, solid steel casting. The housing for these worms is accurately machined and hot riveted to the supporting post, so there can be no lost motion at that point. The hand wheel hub has a flange cast on it to match the flange on the worm. These two flanges are bolted together, so there can be no lost motion at that point. The blade lifting arms have ball and socket connections which can be taken up for wear, thus eliminating any possibility of lost motion at those two vital points.

Space will not permit a detailed description of the many other worthwhile features of these, the only really up-to-date Patrol Graders; but the catalog tells the whole story and the coupon makes it easy to ask for your copy. Better tear it off now while you are reading this page.

Above: At no point in the entire blade control mechanism can lost motion creep in.

Below: Worm, shaft and flange are a single steel casting.



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VOL. 56 NO. 1

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JULY, 1925

PUBLIC WORKS

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

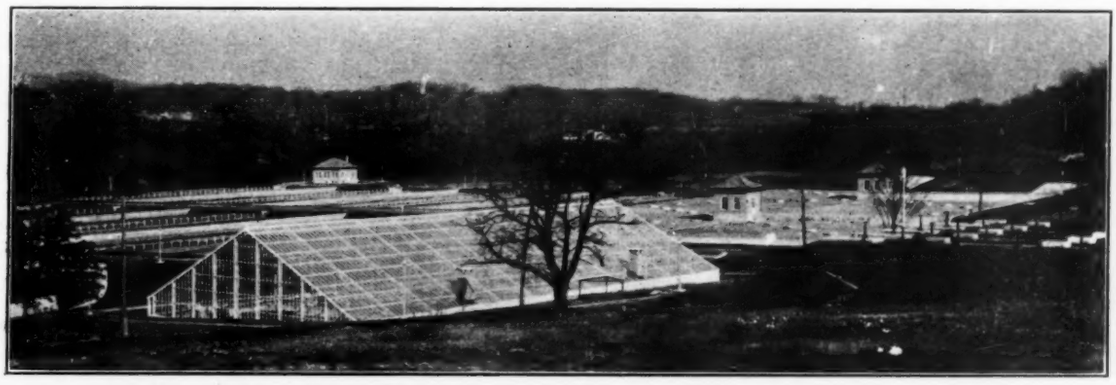
Vol. 56 JULY, 1925 No. 7

Sewage Treatment Plant at Boonton

Constructed and operated by Jersey City, N. J., in connection with the Rockaway Valley Trunk Sewer. Many unusual features, including glass-covered sludge drying beds. Plant includes settling tanks, aerator manholes, contact beds, sand filters, chlorinators, sludge digestion tanks, sludge drying beds, and a sand washer.

By Clyde Potts

Jersey City derives its water supply from the Rockaway River, with storage reservoir at Boonton, impounded by the well known Boonton Dam. While the greater part of the watershed is sparsely populated, there are several municipalities along the line of the old Morris Canal and the Dover branch of the D. L. & W. railroad. None of these municipalities was sewered, and the lack of sewerage has been felt, particularly in Dover, the largest of the municipalities.

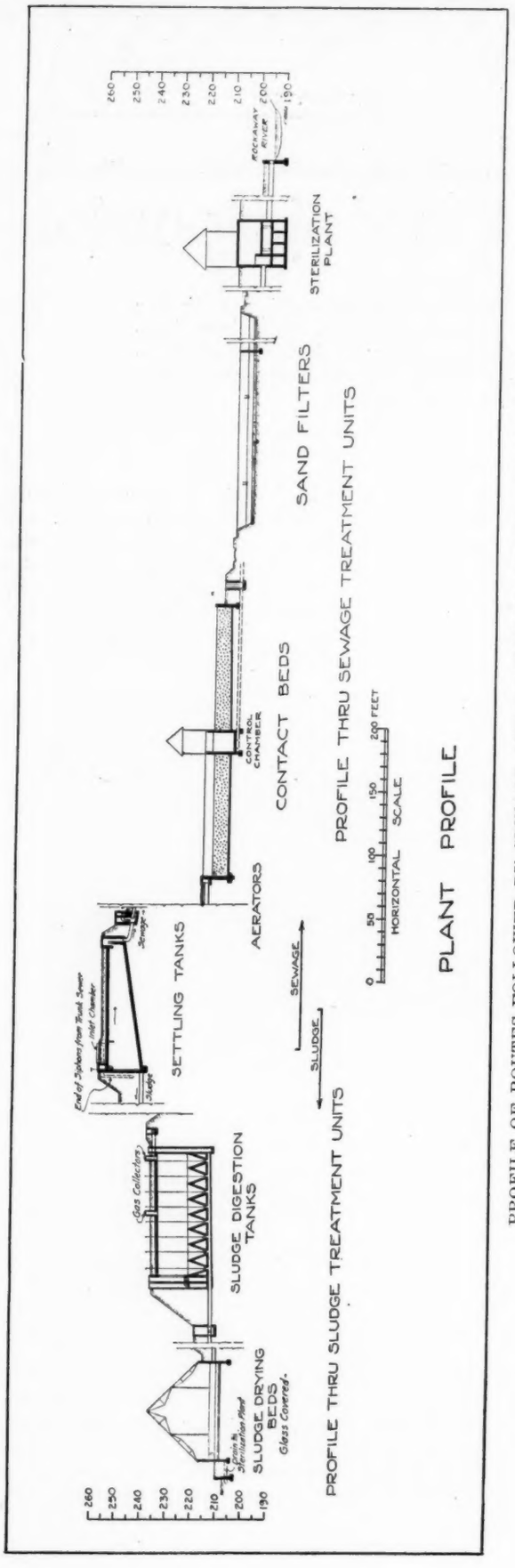


GENERAL VIEW OF SEWAGE TREATMENT PLANT, TAKEN FROM SETTLING TANKS.
Sludge digestion tanks at right. Sand filters behind greenhouse, contact beds beyond these, and sterilization plant in rear.

The project of constructing a trunk sewer to serve the municipalities on its watershed and preserve its water supply has been considered by Jersey City for some years. In 1917, when Commissioner Michael I. Fagen took charge of the Department of Streets and Public Improvements, including the water supply at Boonton, he directed the writer to prepare plans for the intercepting sewer and disposal works so long contemplated. Commissioner Fagen and the writer were both impressed with the possibilities of the activated sludge type of plant then coming into use. It had an added advantage at Boonton because sufficient water power was available at the gate house to operate the air compressors. The first plans called for activated sludge tanks, with sludge digestion tanks for the purpose of rotting out the sludge from the activated sludge tanks. This seemed to be a sensible way of disposing of the troublesome sludge problem growing out of the activated sludge system. It is interesting to note that Dr. Imhoff has recently advised this same preliminary and sludge treatment for the activated process.

This project was opposed in Chancery Court by the water companies using the Passaic river below the point of discharge as a water supply. The activated sludge process was attacked by experts for the water company on the grounds that it was a new, untried process. It was ruled by the Court that the application for the injunction would be denied if Jersey City installed a plant similar to the Morristown or Madison-Chatham plants, with secondary treatment by contact beds and sand filters. This type of plant was favored by experts for the water company.

The present plant was designed in 1922. Construction was started July 5th, 1923, and it was completed in October, 1924. Owing to delay caused by the abandonment of the Morris Canal, along which part of the line runs, part of the trunk sewer



PROFILE OF ROUTES FOLLOWED BY SEWAGE AND BY SLUDGE; PLANT AT ROONTON, N. J.

has just been completed. The Dover sewer system is now practically complete and the plant should be placed in operation this month.

The plant has a rated capacity sufficient to care for 20,000 people, but the units have capacity to allow rates considerably in excess of this.

The general arrangement of the plant is shown on page 233.

The trunk sewer terminates in the upper siphon chamber just below the dam at its northerly end. In this chamber the sewage passes through a coarse bar screen and over duplicate V-notch weirs. The weirs are equipped with an indicating, integrating and graphic recorder.

From this chamber, duplicate cast-iron siphons carry the sewage across the river below the dam to the inlet chamber of the settling tanks.

SETTLING TANKS

The inlet chamber provides a small stilling chamber with 12 weirs. Each weir connects with a separate pipe, each leading to one of the 12 settling tank units. These distributing pipes are carried on the roof of the tanks. This arrangement of inlet piping is for the purpose of allowing equal distribution of the flow to the different units, a factor lacking in many plants. By the use of individual distributing pipes, the silting up of large inlet channels is avoided.

Each settling tank unit is 12 feet wide and 100 feet long, with depth of from 13 feet at the inlet end to 6 feet at the outlet end.

The bottoms of the units have V-shaped cross sections.

The sludge outlets are at the deep end of the tanks, where 12-inch sluice gates admit sludge to the sludge lines. Surface baffles are provided at the inlet and outlet ends of the tanks. Sewage enters each tank through two 12-inch pipes with ¼ bends pointing towards the end of the tank against the direction of the flow. Two weirs at the outlet end will collect the flow over the entire width of the tank. By raising or lowering the elevation of these weirs with stop planks the sewage level in the tanks may be maintained above or below the under surface of the roof. By submerging the roof, scum drying is prevented. Adjoining units are connected at the shallow ends, by 12-inch pipes with sluice gates. When a tank is cleaned, it may be completely emptied and flushed clean by sewage from an adjoining tank. The capacity of each unit is 82,500 gallons, giving a total capacity for the 12 units of 990,000 gallons.

AERATOR LINE

The topography of the site provided a difference of elevation of about 30 feet between the outlet channel of the settling tank and the contact beds. To allow this head to do some work, aerators were installed. The cascade type of aerator was not used, to avoid the possibility of odor from wind-blown spray, as found with sprinkling filters. Instead five aerator manholes are installed along duplicate cast-iron pipes connecting the settling tanks and contact bed. Each contains two siphons arranged so that one will function when the flow exceeds the capacity of the other. Air piping will allow air to be added by inspiration, preventing possibility of aerial nuisance.

CONTACT BEDS

There are two sets of contact beds, each with four units. The settled sewage may be diverted to either or both sets. Automatic control will divert the flow to the units in rotation, allowing each to fill to any desired level, and automatically emptying the bed when the next unit has filled to any desired elevation. Each unit is 105 ft. 6 in. square, with net depth of stone of 6 feet. The media is crushed trap rock.

SAND FILTERS

Each contact bed connects with a sand filter, and a valve manhole is provided to cross connect the pipes so that any contact bed or sand filter may be cut out of service. There are eight sand filter beds, each with 270 feet by 135 feet of sand surface. Each filter bed is divided into two halves by wooden partitions. The flow may be directed to either or both sides of a bed. By running the sewage to one-half of a bed only, better distribution will result. Sand is 2 ft. 6 in. deep on 6 to 12 inches of broken stone.

CHLORINATION

The underdrains of the sand filters connect with a main collector leading to the sterilization plant. The clarified sewage passes through a weir chamber with float and recording gage, and through an inspection well where the quality of the effluent may be observed at all times. After the application of chlorine, the effluent passes through detention tanks with a period of one hour.

Tanks for chloride of lime and a pedestal type liquid chlorine feed are provided, so that either may be used. The building has a convenient platform for unloading chemicals, with ample storage space within and a small crane for handling drums.

The sterilized effluent passes to the river.

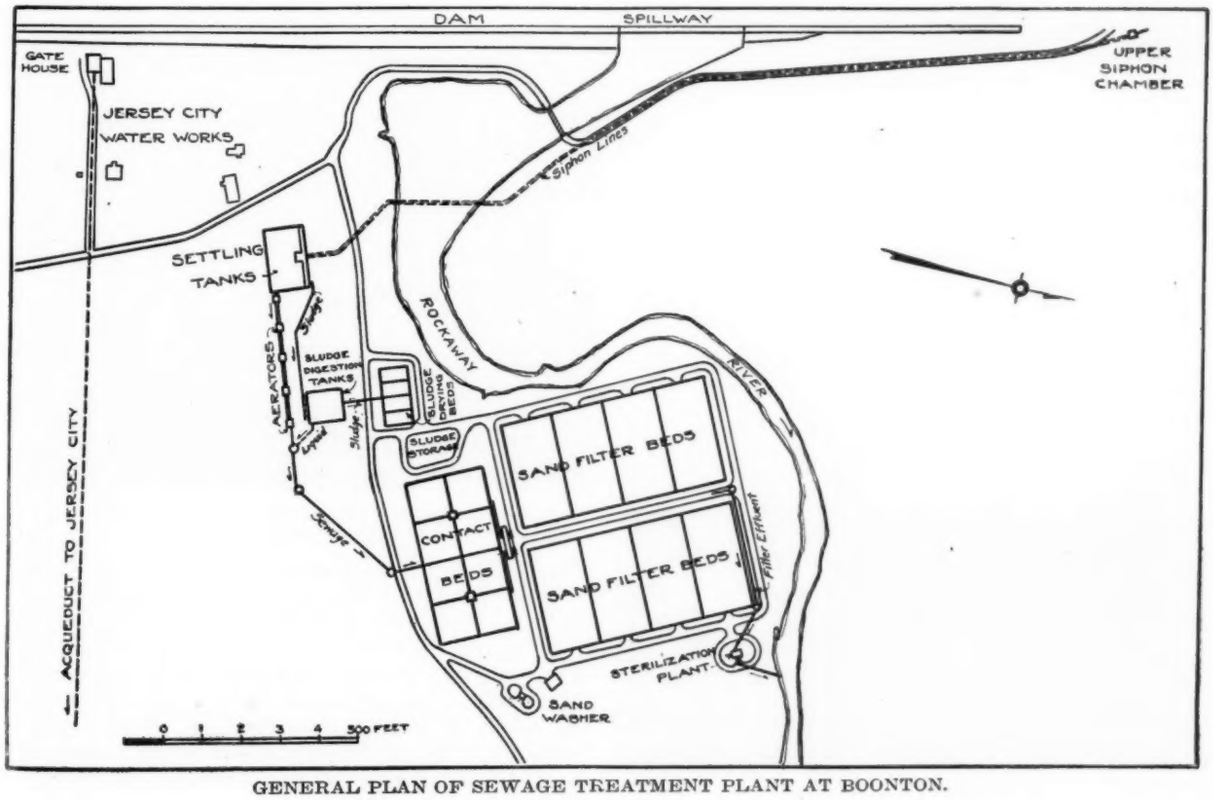
SLUDGE DIGESTION TANKS

Sludge from the settling tanks is discharged by gravity to the sludge digestion tanks. There are five units, each with a capacity of 123,000 gallons, making the total capacity 615,000 gallons. Fresh sludge may be admitted through the tops of the tanks at four points along each tank. It may also be admitted through the sludge pipes under the tanks to any of the eight hoppers in each unit. The units may be operated with the liquid above or below the underside of the roof. Fresh sludge may be added to a full digestion tank, the displaced liquid passing through a special slide valve at the end of the tank to a regulator tank. This tank is of the same size as the digestion tanks. It is filled with the displaced liquid from the digestion tanks when fresh sludge is added, and is emptied at a slow uniform rate by a floating outlet pipe. The effluent joins the main effluent line and receives the subsequent treatment by contact beds, sand filters and sterilization.

All gas from the digestion tanks will be collected, and piped to a small gas holder. The gas will be used to warm the glass-covered sludge-drying beds in winter and to warm the contents of the sludge digestion tanks.

Sludge may be drawn from any of the forty hoppers, and discharged by gravity to the sludge-drying beds.

All sludge pipes are provided with cleanout connections in manholes and water connections for flushing.

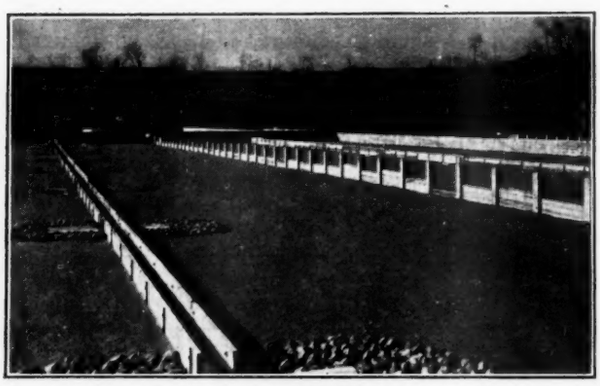


GENERAL PLAN OF SEWAGE TREATMENT PLANT AT BOONTON.

SLUDGE-DRYING BEDS

The sludge-drying beds have a total effective area of 11,046 square feet, providing 0.57 square feet per capita. They are divided into four units. The sand is 12 inches deep and rests on 6 to 9 inches of gravel. The beds are covered with a glass superstructure of the greenhouse type. This idea seems to have originated at the Cleveland experiment station in 1913. The glass superstruction will make sludge drying independent of weather conditions, permitting the use of about half the sludge bed area that would be required with open beds. Recording thermometers show the glass covering is an effective heating unit, the interior temperature exceeding the outside readings by more than 30° F. at times. The glass superstructure adds to the attractive appearance of the plant.

Industrial tracks are placed in each bed and connect with a main track that runs along the top of the sludge dump retaining wall. Dried sludge may be dumped directly into wagons or trucks. The track continues to a sludge storage area where sludge not disposed of directly to trucks may be stored. This

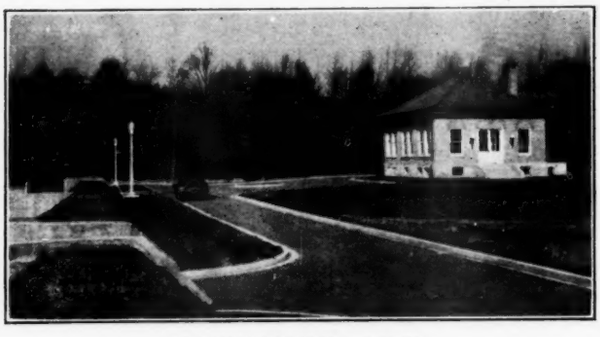


SAND FILTER BED.
Boonton dam and spillway in rear.

area is surrounded by a concrete cut-off wall and is underdrained, and the seepage from this area and from the sludge drying beds is sterilized before reaching the stream.

SAND WASHER

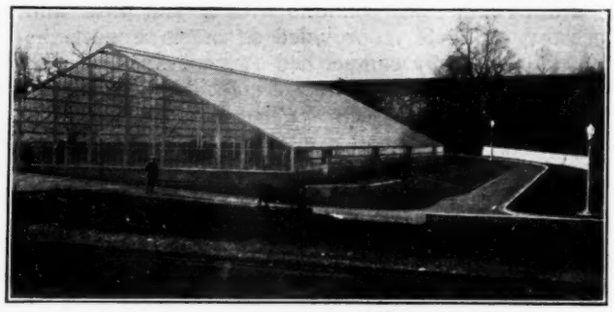
A sand washer is provided to clean any sand from the filters that becomes fouled. Two concrete hoppers with water connections at the bottom project from the hillside adjacent to the sand filters. The structure and roads are arranged so a truck may drive above the hopper, dump its load of dirty sand, and then drive below the hopper and fill with cleaned sand. The spent water from the sand washer will be filtered on a small sludge bed, and the effluent will be sterilized.



STERILIZATION PLANT.
Sand filters at left.

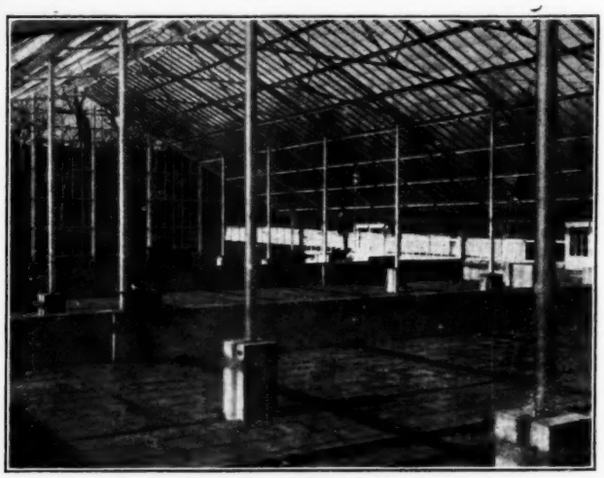
GENERAL

The Boonton reservoir, surrounded by wooded hills, is a spot of great natural beauty. To place a sewage treatment plant adjoining the water works at the dam required careful design to harmonize with the natural surroundings, therefore in the design



GLASS-COVERED SLUDGE DRYING BEDS.
Storage area for dried sludge in foreground.

and construction of the plant, an effort was made to detract in no way from the attractiveness of the property. Macadam roads, with concrete curb and gutter, are lighted by concrete lamp posts of pleasing design. The settling tanks and sludge digestion tanks are covered with earth and seeded and all slopes between units are grassed. Existing trees around the plant were preserved. Another factor considered was the objection to the plant by the Town of Boonton. While no residences are near the plant, it was imagined that the odor would be



INTERIOR OF GLASS-COVERED SLUDGE DRYING BEDS.

objectionable. The detection of any odor right at the plant should be difficult. No sewage is exposed to the air until the sand filters are reached, when the exposed liquid is the effluent from the contact beds. All gas evolved from the digestion of the sludge will be collected and burned, and the sludge beds are covered.

The plant was designed to utilize as far as possible the natural advantages of the site in a practical way. Settling and sludge tanks may be completely drained

RETAINING WALL ALONG RIVER. SAND FILTERS AT RIGHT.

by gravity. The units were placed so that cut and fill balanced. The slope of the bottom of the settling tanks followed the natural slope of the ground, reducing the cut required.

The trunk sewer and sewage treatment works were constructed by Jersey City, under the jurisdiction of the Department of Streets and Public Improvements, Michael I. Fagen, director, and Edward B. See, chief clerk. The design and construction of the work was under the direction of the writer as consulting engineer for the city. Frederick Guerin was resident engineer, and Nelson Butera, assistant resident engineer. The superstructures were designed by Abraham Slavin, architect, and the detailed design of the plant supervised by Weston Gavett. The contractor on the plant and lower section of the trunk sewer was the Alberta Contracting Corporation, Joseph Sigretto, president.

Muscle Shoals Power

Such superlative adjectives have been used in describing and referring to the power to be derived at Muscle Shoals and the dam that has been built by the government for that purpose, that there is a popular belief that this project exceeds in importance any other that has been or can be developed in the entire country. As a matter of fact, this is far from being the case. In a paper before the American Institute of Electrical Engineers, Samuel S. Wyer gave some definite figures on the subject which presented the matter in a different light. He stated that Niagara Falls alone could develop thirty-five times the power available at Muscle Shoals without affecting its scenic value, and in the entire United States there is available at least two hundred and fifty times as much water power. "The actual dependable water power of Wilson dam, the only part of the Muscle Shoals project under construction, is only 100,000 horse power. The other power talked of is unreliable and therefore available only if supplemented by power from steam plants or from other inter-connected power plants." When the project has been completed and is ready for applying power, it will have cost about $49 000,000 or about $490 per horse power. "Any high grade steam plant, allowing also a reserve equipmant in case of emergencies, will produce a horse power at an investment cost of $100."

Chlorination of New York's Water Supply*

Three primary chlorinating plants and proposed secondary chlorination of the Catskill supply after leaving open reservoir at Hillview.

By William W. Brush†

The surface water supplies of the City of New York are mainly obtained from the Catskill and Croton watersheds. The existing protection from pollution of these waters is secured by watershed patrolmen, by the city ownership of a small portion of the land bordering on the streams, and by the city ownership of all lands bordering on the various reservoirs. The waters are used by bathers in the streams and lakes not owned by the city and there is a population of about 25,000 people on the 375 square miles of the Croton shed and a winter population of 13,900 and a summer population of 35,500 on the 571 square miles of the Catskill shed. The purification of the waters is secured by chlorination of part of the water before it enters the main storage reservoirs, by long sedimentation in the storage reservoirs, usually represented by several weeks detention, and by chlorination after leaving the main storage reservoirs.

SANITARY CONDITIONS ON THE CATSKILL WATERSHEDS

There are two main watersheds on the Catskill system known as the Esopus and Schoharie. The latter has been available only since the eighteen-mile Shandaken tunnel was completed in February 1924, and now delivers about one-third of the Catskill supply. At the end of 1925, with the completion of the Gilboa reservoir, the Schoharie will deliver one-half of the supply. There are five villages, each with several thousand inhabitants in the summer season, which are to be sewered at the expense of the city, but these systems have not yet been installed, and the water is not now as free from pollution as it will be a year or two hence, when this has been done. The watershed is generally used as a summer vacation area and many bathe in the small ponds along the streams tributary to the reservoir. The individual toilets and the sanitary conditions on the farms have been looked after by the city. The average bacterial and B. coli content of the Schoharie water as delivered into the Esopus during 1924 has been: Bacteria 550; B. coli per 10 c. c., 201.

On the Esopus watershed the city has constructed one sewage collection and disposal system and plans to construct three more which will adequately care for the communities on this watershed, which are smaller than those on the Schoharie shed. The bathing and summer visitor situations are similar to those on the Schoharie shed. The average bacteria and B. coli content of the Esopus water during

*Paper before American Water Works Association.

†Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, City of New York.

1923, before the Schoharie water was added, was: Bacteria 34; B. coli per 10 c. c., 5.

CHLORINATION PLANTS ON THE CATSKILL SYSTEM

Boiceville: This plant is located on the Esopus creek just above the upper end of the Ashokan reservoir and prior to the utilization of the Ashokan reservoir plant in January, 1925, was operated continuously except when flood flows were in excess of its capacity of about 1000 m.g.d. This plant is to be used hereafter during the summer season to counteract the bathing and summer vacationist pollution and will treat both the Esopus and Schoharie waters.

Ashokan Reservoir: This plant is located in the screen chamber at the head of the aqueduct and was placed in service on January 5, 1925. It treats all the Catskill water. Due to the usual long period of sedimentation in the reservoir and the division of the reservoir into two basins, the water is generally in a very uniform condition and low in bacteria, including b. coli; but at times of heavy flood flows the water may have a relatively high turbidity and reach the outlet chamber in a couple of days after entering the reservoir. When the construction of sewers on the watersheds has been completed it may be deemed advisable to operate this plant only when the water is polluted by flood flows, but this question is one for determination in the future.

During 1924 the average condition of the water as delivered into the aqueduct was: Bacteria 84; B. coli per 10 c. c., 0.45; turbidity 5. Its condition as drawn at time of high turbidity was; Bacteria 152; B. coli per 10 c. c., 0; Turbidity 16.

Kensico Reservoir: The plant at the screen chamber on the aqueduct below the effluent chamber of Kensico reservoir is the main plant and has been designed to maintain constant delivery of chlorine into the supply. For a very few hours each year there have been interruptions in the flow of chlorine, but the prior purification of the water has been so consistently high that such interruptions have not been considered serious. Kensico reservoir has a tributary watershed of 22 square miles and a flow from the Ashokan reservoir of about 600 m. g. d. The tributary watershed is rather sparsely settled and the pollution reaching the water is limited to surface wash. Since the Catskill aqueduct was completed to its full capacity in December, 1924, the flow into the reservoir has increased fifty per cent, reducing the average time of the water passing from the influent chamber to the effluent chamber (a distance of three miles) from about three weeks to two weeks. The Kensico reservoir has an available content of 30,000 m. g. but a large portion of this water is stored in the reservoir outside of the line of flow from the influent to the effluent chamber.

The average condition during 1924 of the raw water from Kensico reservoir and the treated water was:

Raw water: Bacteria 25; B. coli per 10 c. c., 0.12.

Treated water: Bacteria 8; B. coli per 10 c. c., 0.005.

The turbidity of the Kensico reservoir is usually two to three parts per million on the silica scale, and the maximum turbdiity was five in 1924.

CONDITIONS TO BE MET BY THE HILLVIEW RESERVOIR CHLORINATING PLANT

After the water passes the Kenisco chlorination plant it flows through fourteen miles of aqueduct consisting of concrete cut and cover, concrete-lined grade tunnel, concrete-lined pressure tunnel, and steel pipe siphon types of construction. The hydraulic gradient is below the ground water level for various portions of this distance and a possibility of pollution exists although at present it is very slight. Hillview reservoir is an open basin with a dividing wall usually below the water surface and through which a by pass conduit is constructed which can carry about two-thirds of the present demand. From the end of August until the following April sea gulls flock to this reservoir, at times numbering thousands. They arrive about eight o'clock and remain until dusk. If an airplane passes over the reservoir they will disappear for the remainder of the day. Under the New York State laws they cannot be killed and the legislature has refused to modify the law to permit these birds being killed if found on a distribution reservoir. For the greater part of the time one to two men are kept out on the surface of the reservoir in a boat to shoot at the birds in such a manner as to have the shot hit the water but not hit a gull. Experience over several years has shown that the birds soon lose their fear of the men and cannot be driven away in this manner unless more boats be used. The effect of the gulls on the pollution of the supply is evident in the late summer and fall as shown by the average B. coli content during this season and the season when the gulls are not present. In the cold weather the effect of the gulls is not noticeable in the B. coli content. The water after treatment at Kensico, as shown by daily tests, was free from B. coli in 10 c. c. during the entire twelve months with the exception of one sample and was also virtually free from B. coli in 100 c. c.

1924	B. coli content in 10 c. c. after the water left Hillview reservoir
Prior to August	0.
August	0.10
September	1.73
October	0.80
November	0.02
December	0.

This result was shown in spite of the by-passing of the reservoir during September and October to the extent that the capacity of the by-pass permitted.

The Hillview reservoir is surrounded by a wire mesh fence six feet high of non-climbable type and set back about twenty feet from the water line. The State Department of Health officials have suggested that the water might be contaminated by throwing something over the fence either with deliberate intention or due to ignorance. There are very few visitors to the reservoir grounds and the chance of such pollution seems very slight.

Microscopic organisms, especially synura, have developed in the Kensico reservoir without being detected by the daily laboratory examination before

a distinct taste has been imparted to the water by the chlorine destroying these organisms. The synurae have been controlled up to about 100 units per c. c. c. by excess chlorination, copper sulphate treatment being resorted to as soon as possible after the synura organisms have been noticed.

REASONS FOR PROPOSING TO OPERATE BOTH THE KENSICO AND PROPOSED HILLVIEW CHLORINATING PLANTS

When the Hillview plant is installed, which it is expected will be during 1925, we propose to operate both plants for the following reasons:

a. The Kensico plant will give warning of the presence of synurae in sufficient numbers to cause taste, before the laboratory might notice them. This taste when first noticed generally disappears during the six hours required for the water to flow to Hillview and by increasing the chlorine dose at Kensico the taste is removed pending the destruction of the synurae by copper sulphate treatment. Without the treatment at Kensico the taste created by chlorination at Hillview when synurae are present would not be dissipated before the water reached the consumer, which for some sections of the city would be within an hour.
b. Secondary chlorination at Hillview virtually removes any chance of any particle of water reaching the consumer without being treated.
c. Hillview reservoir effluent chlorination will counteract the gull pollution and any accidental or intentional pollution of the water while in Hillview reservoir. After the water leaves the reservoir it is under a pressure which exceeds the outside ground water pressure at all points, thus preventing any subsequent pollution.
d. The chlorine dose at Hillview can be maintained at a lower rate if it follows a previous chlorination about twelve to twenty-four hours earlier at Kensico and thus minimize the danger of any excess chlorine taste due to difficulty in control of amount of chlorine with the daily and hourly fluctuations of the draft from Hillview reservoir to meet the consumption demand.
e. Elimination of any reasonable basis for any suspicion of the sanitary quality of the Catskill water as delivered if any unusual rise in the typhoid fever rate developed, such as was traced to oyster pollution during the past winter.

CONCLUSION

The dependence on chlorination for the safety of a water supply demands a higher degree of insurance of adequate and absolutely continuous treatment of the water than has been the general practice to date. The use of the excess chlorine control method has been a great aid in determining the safe minimum dose but more attention should be paid to the possibility of drops of water passing the treatment plant either untreated or insufficiently treated. Turbidity means that bacteria may be encased in matter in suspension which is not broken up or penetrated by the chlorine. The delivery of the chlorine is not uniform enough and is not distributed generally in a thorough enough manner to insure at all times sterilization of the entire mass of water treated. Secondary pollution in open reservoirs or in conduits with gradients below the water level in the surrounding soil may occur and must be counteracted by secondary treatment.

This subject is a most important one and is deserving of consideration and discussion with a view to placing the chlorination of water supplies on a safe and more logical basis than exists today.

Refuse Disposal at Municipal Camps

The number of municipal and other public camps provided for autoists, including also those used by boy scouts, Y. M. C. A.'s, etc., has been increasing rapidly during the past two or three years, and the problem of the sanitation of these camps has become an important one. One of the problems, that of disposing of the garbage, has not received as general attention as the water supply and sewerage, partly because it is of less real significance to health but also probably because of the difficulty in finding a satisfactory solution. The two methods most commonly used, and perhaps the only two generally available, are burying and burning. The former requires more labor and also available land sufficiently free from roots, stones, and so forth, and burning seems to be the only practicable choice in many cases. Burning in the open is apt to cause nuisance by odors, especially when the dying fire is smoldering, and is interfered with by rainy weather, so that an incenerator is desirable. The conditions are generally such that the incinerator must be simple and cheap and at the same time effective.

To meet these conditions, the Maryland Bureau of Sanitary Engineering has designed an incinerator which is rectangular in shape with outside dimensions 5′4″x3′2″ and 2′5″ high. It is of the return heat type with a single charge capacity of approximately one cubic foot of garbage, which can be consumed in forty-five minutes burning time. The cost of the incinerator varies, depending upon the character of the material used, the location and the method of construction, but the cost should probably not exceed $20 to $35.

Sewer Cleaning in Portland

The city engineer of Portland, Oregon, O. Laurgaard, informs us that during the year ending November 30th, 1924, more than 200,000 lin. ft. of sewers were cleaned at an average cost of 2.7c. a foot, while more than 428,000 feet were flushed at a cost of 0.12c. a foot. The cleaning method employed last year was that of dragging a heavy knot of chains through the sewer while flushing with a heavy stream from a fire hose. When the knot is within about 20 feet of the lower manhole, water pressure is shut off, and the accumulated sand, gravel, and so forth is dragged to the manhole and shoveled out. The knot of chains is pulled back and forth through the sewer by a wire cable, using windlasses that form part of the equipment of the city's Turbine sewer cleaning machine. The size of the knot is varied to suit the size of the sewer, a diameter about 2 inches less than that of the pipe being most frequently used.

In some streets near the sand and gravel bunkers

it is necessary to clean the sewers quite frequently. Some times they are found nearly half full of sand, as few of these sewers have catch basins, the inlets leading directly to the sewers and admitting everything that is washed in from the street. Masses of roots eight or ten feet long entirely filling an eight inch pipe have been taken out with the chain drags.

About ten years ago, the city bought a Turbine sewer cleaning machine and considerable use was made of it during the next year or two. Masses of roots, sticks, sand and so forth, were loosened and taken out, and layers of cement mortar which in some cases filled a ten or twelve-inch pipe nearly half full were broken up and removed with the help of this machine.

The hose used with this machine wore out quickly when dragged over the street and through the sewer, and after the first lot of hose had been worn out, the Council refused to buy new hose to operate the Turbine properly, and has continued to so refuse until the present year. When the hose shortage prevented the use of the Turbine machine, the sewer cleaning gang developed the method described above.

Another piece of sewer cleaning apparatus that has become indispensable is the self-propelling nozzle, which forces its way a hundred feet or more through an ordinary sewer stoppage, pulling the hose after it. This nozzle is used by the emergency crew for opening stopped inlet pipes, etc.

The sewer cleaning gang consists of a sub-foreman and three laborers, the former receives $5.10 per day and the latter $4.85 each.

A Concrete Road After Ten Years of Traffic*

Condition of the Ohio Post Road, As Determined By a Survey Made for the Division of Tests, U. S. Bureau of Public Roads

Reported by F. H. Jackson, Engineer of Tests

One of the first concrete pavements of any considerable length to be constructed in the United States was laid in 1914 and 1915 on a section of the old National Road between Zanesville, Ohio, and the Moscow bridge over the South Fork of the Licking river, a distance of about 24 miles. The pavement, built under the joint supervision of the State of Ohio and the United States Bureau of Public Roads and known as the Ohio Post Road, has now been under traffic for more than ten years and is still in good condition.

Fortunately there is available a detailed record of the materials and methods used in the construction and there is the possibility, so often lacking, of studying the present condition in the light of the conditions obtaining during construction. With this possibility in view the road was inspected for the Bureau of Public Roads in November, 1924, and observations made at that time are recorded in this article.

One condition that stands out very clearly is that there were about twice as many full transverse cracks per mile in parts of the pavement in which uncrushed gravel was used as the coarse aggregate in comparison with other parts in which the aggregate was crushed limestone.

Another noticeable condition is the entire absence of scaling, which the writer attributes to the fact, as evidenced by the records, that the sand was exceptionally clean, the mix dry and the finishing moderate. So excellent is the surface in this respect, and so strong the indications of the records that the result is due to the construction conditions mentioned, that the writer feels justified in saying that more careful attention to these details should go far toward eliminating scaling on new construction.

The observations also add to the evidence which is piling up from similar investigations in many parts of the country that there is an intimate relation between the extent of cracking in concrete pavements and the character of the soil immediately below the pavement. In the Ohio Post Road, as in the Columbia Pike in Virginia and other roads which have been the subject of recent reports, the greatest amount of cracking has occurred on soils of high clay content.

GENERAL DESCRIPTION OF THE ROADS

Ten of the 24 miles was surfaced with 1:1½:3 concrete using uncrushed gravel aggregate, the remaining 14 miles with 1:1¾:3 concrete in which the aggregate was crushed limestone. Throughout its entire length the pavement is 16 feet wide and the slab, which is 8 inches thick at the center and 6 inches at the edges, rests on a flat subgrade. Contraction joints were spaced 30 feet apart and were skewed at an angle of 15° with the center line of the road. One thickness of two-ply tar paper was used in the joints except for a few miles on which ¼-inch premolded expansion joints were tried.

The macadam surface over which the concrete was laid had received practically no attention for a number of years prior to the improvement, so that it was in a very poor state of repair. In many places the stone had disappeared entirely and during wet seasons, sections of the road became almost impassable. With few exceptions the line of the survey for the improvement followed the center line of the old road, and in no case was the departure greater than 10 or 15 feet. The maximum grade of the improved road is 7 per cent. The soil of the region which the road traverses consists for the most part of a heavy red clay with here and there an admixture of blue pipe clay which is very difficult to drain. The topography is rather rugged, afford-

*Somewhat condensed from an article in "Public Roads," the official journal of the Bureau of Public Roads.

ing good natural drainage for the most part, there being only about 1¾ miles at the extreme western end of the improvement—a practically level stretch—in which this condition does not obtain.

The sand used in the concrete was exceptionally well graded and clean, the maximum silt content shown by any of the analyses being 2.6 per cent, and the maximum passing a 100-mesh sieve 4 per cent. In only one of the eight analyses reported was the silt content greater than 1.3 per cent. The uncrushed gravel and crushed limestone used as coarse aggregates were of good quality. The water, pumped from streams crossed by the road, was also of good quality.

Aggregates were stored on the subgrade and were proportioned by means of wheelbarrows of such size that the desired quantities were secured by striking off the materials level with the tops. The concrete was mixed in one-half cubic yard paving mixers of the boom-and-bucket type, and in general the mixers were so operated that each batch of concrete remained in the drum at least 45 seconds. Great care was exercised to regulate the consistency of the mix so that the concrete would hold its shape after being placed, struck off, and finished. All reports on file indicate that more than usual attention was given to this feature, and that the concrete was, if anything, too dry rather than too wet. This point is also of interest in view of the present condition of the pavement. The concrete was struck off by means of a wooden strike board and tamped with a steel templet 6 inches wide and shaped to conform to the surface.

Finishing the surface proceeded immediately after the tamping, using wooden floats of two sizes, one about 8 feet long, operated by two men, and the other about 2 feet long, operated by one man. The long float was operated from two bridges and was shoved back and forth longitudinally across the pavement. The short one was for final finishing. For the most part the surface was brought to final finish not more than 50 feet behind the mixer. Although the finish was good, there was no attempt to secure a surface of exceptional smoothness, such as

THE OHIO POST ROAD.
The shoulders are below the edges of the pavement in places but, in general, the drainage conditions are good.

is frequently made in current practice. There was consequently little tendency toward overfinishing.

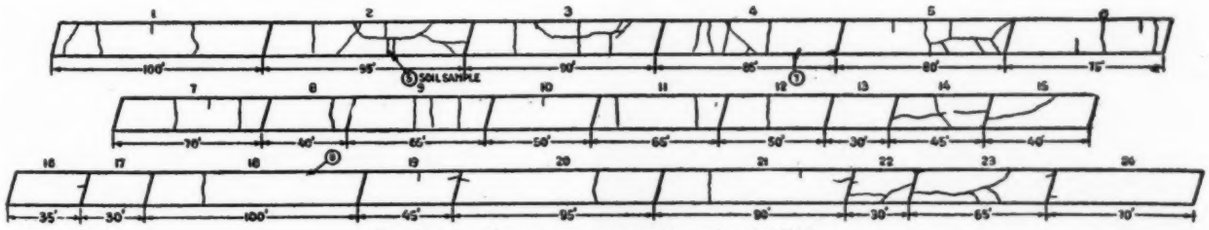
Thus, it is noted that three of the factors which from time to time have been brought forward as causing surface scaling, viz, excessive fine material in the sand, wet mix, and overfinishing, were conspicuously absent on this job.

A canvas cover was spread over the surface of the concrete as soon after it was finished as possible. From 15 to 24 hours after laying, the canvas was removed and a 2-inch earth covering was placed and kept continuously wet for a period of two weeks, after which it was removed and the road opened to traffic.

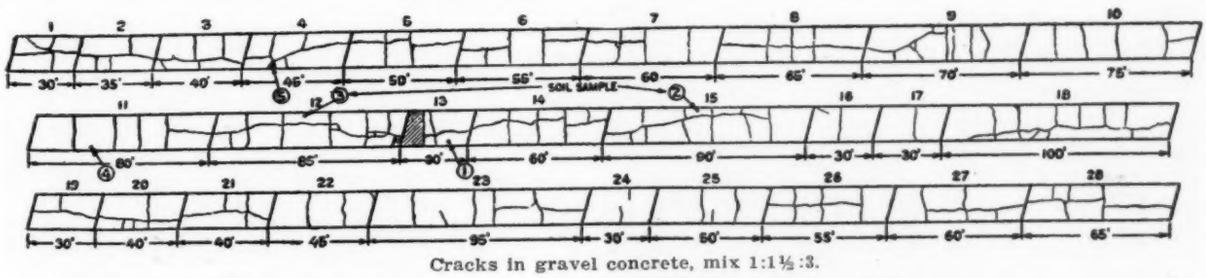
Compressive tests were made of concrete cylinders taken from time to time during the progress of the work. The crushing strength at 14 days of the 6 by 6 inch cylinders of both kinds of concrete ranged from about 2,400 to about 3,400 pounds per square inch, averaging approximately 2,800 pounds. There was very little difference in the crushing strength of the two classes of concrete.

RELATIVE CRACKING OF GRAVEL AND LIMESTONE CONCRETE

As the same sand and cement and the same details of construction were used throughout, the possibil-



Cracks in limestone concrete, mix 1:1¾:3.



Cracks in gravel concrete, mix 1:1½:3.

CRACK SURVEY OF EXPERIMENTAL SECTION OF OHIO POST ROAD.

Figures above and at center of each section indicate number of section. Figures below each section indicate its length in feet. Shaded area indicates bituminous concrete replacement.

ity of comparing the behavior of the two kinds of concrete was anticipated when the road was built, and two special experimental sections were laid. The sections were so located as to have practically identical traffic, subsoil, and drainage conditions. Both were constructed through gently rolling country; each contained approximately the same amount of pavement through cut and on fill, and each was constructed with contraction joints varying from 30 to 100 feet apart, the distance changing by increments of 5 feet and repeating for a distance of approximately 1 mile in each case. Thus all the conditions on these two experimental sections were nearly alike with the exception of the kind of coarse aggregate.

A detailed crack survey was made at the time of the recent inspection. Many more cracks were found in the uncrushed gravel section than in the crushed limestone section. The relative amount of cracking may be determined in a number of ways. For instance, by comparing the actual number of concrete slabs formed by the cracks and joints on each section with the total area of the section, we find that the average area of the concrete slabs as they exist to-day on the gravel section is 137 square feet, and on the limestone section is 320 square feet—about two and one-half times greater. On the gravel section every one of the original slabs has cracked at least once; but on the limestone section there are 11 slabs still intact, one 20 feet long, four 30 feet long, two 35 feet long, two 40 feet long, one 45 feet long, and one 50 feet long. There are 230 full transverse cracks on the gravel section and 107 on the limestone section.

As previously stated, a slightly richer mix was used in the gravel concrete—i. e., 1:1½:3 as against 1:1¾:3 for the limestone concrete—but all other factors remained exactly the same, with the exception of the coarse aggregate. It is fair to assume, therefore, that the difference in the cracking of these two sections is due to the character of the coarse aggregate used; possibly to the high tensile strength of the limestone concrete.

SAMPLING SUBGRADE OF OHIO POST ROAD.

RELATION OF CRACKING TO CHARACTER OF SUBGRADE SOIL

During the course of the inspection, 10 samples of subgrade soil were obtained from beneath the edges of the pavement—5 on the crushed limestone section and 5 on the uncrushed gravel section. Certain of these samples were taken at points where extensive cracking had taken place and others on sections which had cracked very little.

Although the number of subgrade samples is too small to warrant drawing any definite conclusions, certain indications seem to show that the amount of cracking may be influenced by the character of the underlying soil. For instance, one sample which showed a very high clay content (65 per cent.) with only 8 per cent. of sand and a moisture equivalent of 22 per cent., was taken from beneath the pavement at a point where considerable cracking had taken place. Another sample carrying 54 per cent. clay, 11 per cent. sand, and a moisture equivalent of 21 per cent., was taken from a point under slab No. 4, which had cracked in several places. On the other hand, a sample taken from under the center of slab No. 11, contained only 36 per cent. clay as against 45 per cent. sand and a moisture equivalent of 15 per cent. At this point no longitudinal crack had developed, and the transverse cracks were from 10 to 20 feet apart.

Sample No. 6, taken from a section where a longitudinal crack had formed and where two transverse cracks extending partly across the pavement had developed only a few feet apart, shows a clay content of 47 per cent., a sand content of 18 per cent., and a moisture equivalent of 22 per cent., while the dye absorption of 38 on this soil was the highest of any of the samples tested. Of four other samples taken at locations where little cracking had developed, two show relatively low clay content and moisture equivalent, with corresponding high sand content, the other two high clay content and low sand content. In the last-mentioned cases, however, both samples contained a considerable amount of coarse material (gravel), which may possibly have increased the stability of the soil, and reduced the amount of cracking. In the case of all four of these samples the percentage of shrinkage of the soil as determined by laboratory test was lower than in the case of sample No. 6. In general, it may be said that the results of the soil tests appear to bear a distinct relation to the amount of cracking in the concrete.

PRACTICALLY NO SCALING OF SURFACE

The road is practically free from surface scaling due, in the writer's opinion, first, to the fact that the sand used in the concrete contained very little fine material; second, to the fact the concrete was mixed dry; and third, that there was no tendency to overfinish the surface. Experience has demonstrated that scaling is very apt to occur on pavements which have been overfinished in an effort to secure an exceptionally smooth surface and that this condition is exaggerated when the concrete is wet and when the fine aggregrate contains a relatively large amount of silt. Some surface wear, however, has taken place on the pavement. This wear is uniform across the road and has taken place to about the same extent

on both the uncrushed gravel and crushed-limestone concrete. The total amount of wear which has taken place in 10 years of service, as near as can be estimated, is about one-eighth of an inch. The wear, however, has not been accompanied by an undue amount of spalling or disintegration of the concrete. This applies to the small slabs which have been formed by the excessive cracking of the gravel concrete and as well as to the edges of exposed joints or cracks. In only a very few cases has it been necessary to replace slabs due to the breaking up of the concrete and this again is a tribute to the quality of the concrete. From present indications, the pavement should be good for many years' service, assuming that proper maintenance is given the joints and cracks.

North Carolina Highway Bulletin

The State Highway Commission of N. C., of which Frank Page is Chairman, has for some time been publishing the "North Carolina Highway Bulletin" which has been very informative not only to the taxpayers of North Carolina, but to engineers and other interested in highways throughout the country. We are informed by the editor, H. K. Witherspoon, that the Bulletin has been discontinued, the May-June issue being the last.

Syracuse Sewage Treatment Works

To handle twenty-seven million gallons a day. Some unusual features are a Venturi meter with capacity for maximum flow; mechanical cleaning of screens; continuous sludge removal from settling tanks; sludge discharged in lagoon with chemical wastes of Solvay Process Co.

Syracuse, New York, has recently put into operation a sewage treatment plant which contains several features of unusual interest, while the entire plant is an excellent illustration of modern high-grade engineering practice. The plans were prepared by the engineers of the Intercepting Sewer Board while Metcalf & Eddy served as consulting engineers. The unique features of the plant are the Venturi flume which measures the entire flow, a grit chamber with automatic control which eliminates excessive loss of head, mechanically raked screens, continuous sludge removal from sedimentation tanks, and disposal of sludge by mixing it with chemical wastes of the Solvay Process Co. The whole plant cost about $425,000 and is designed for a population of 200,000 which is expected to be reached by 1940.

The Syracuse Intercepting Sewer Board was created by special act of the state legislature in 1907 to construct intercepting sewers for removing sewage from two creeks that traverse the city; also for improving the channels of these streams. As this work progressed, other powers were given the Board, one amendment to the act providing for constructing sewage treatment works for the entire city, while another directed it to make a study and plan for draining and sewering all territory within three miles of the city limits and also for protecting the city from flood waters.

Up to May 1st of this year the Board had spent on improving Onondaga Creek $614,760; on main intercepting sewer $848,060; on the Harbor Brook system $232,460; on the West Street system $11,100; on the N. E. storm water outlet $38,100; on the first and second wards storm water system $60,900; on a relief sewer in the abandoned Erie Canal $201,070, and on the sewage disposal works $547,020.

Each of these improvements contains items of

Settling tanks. Pumping station. Grit chamber. Overflow chamber. Gas company's plant in background.

VIEW OF SYRACUSE TREATMENT WORKS.

interest but this article will be confined to the sewage treatment works.

The treatment works are located on an area previously occupied by Onondaga creek before the construction of the Barge Canal harbor and channel. It is in close proximity to the city garbage reduction plant, while immediately east of it a huge gas works is being constructed by the Syracuse Lighting Company.

The result aimed at by these works is not complete purification of the sewage but rather clarification, since it was the opinion of the consulting engineers that Lake Onondaga has sufficient digestive capacity to absorb the sewage for many years to come without the creation of objectionable conditions.

The intercepting sewers bring to one treatment plant the domestic sewage flow of the entire city. The city is sewered on the combined system and provision is made for diverting the excess storm-water from the intercepting sewers when the amount of flow exceeds 130 million gallons a day, the maximum rate which the interceptor can carry. The treatment works are designed to handle 27.5 million gallons per day, but have a maximum capacity of 55 million during storm flows. All in excess of 55 million gallons is diverted to a relief sewer by means of an overflow chamber. This sewer discharges the excess flood water into Onondaga lake at the shore line.

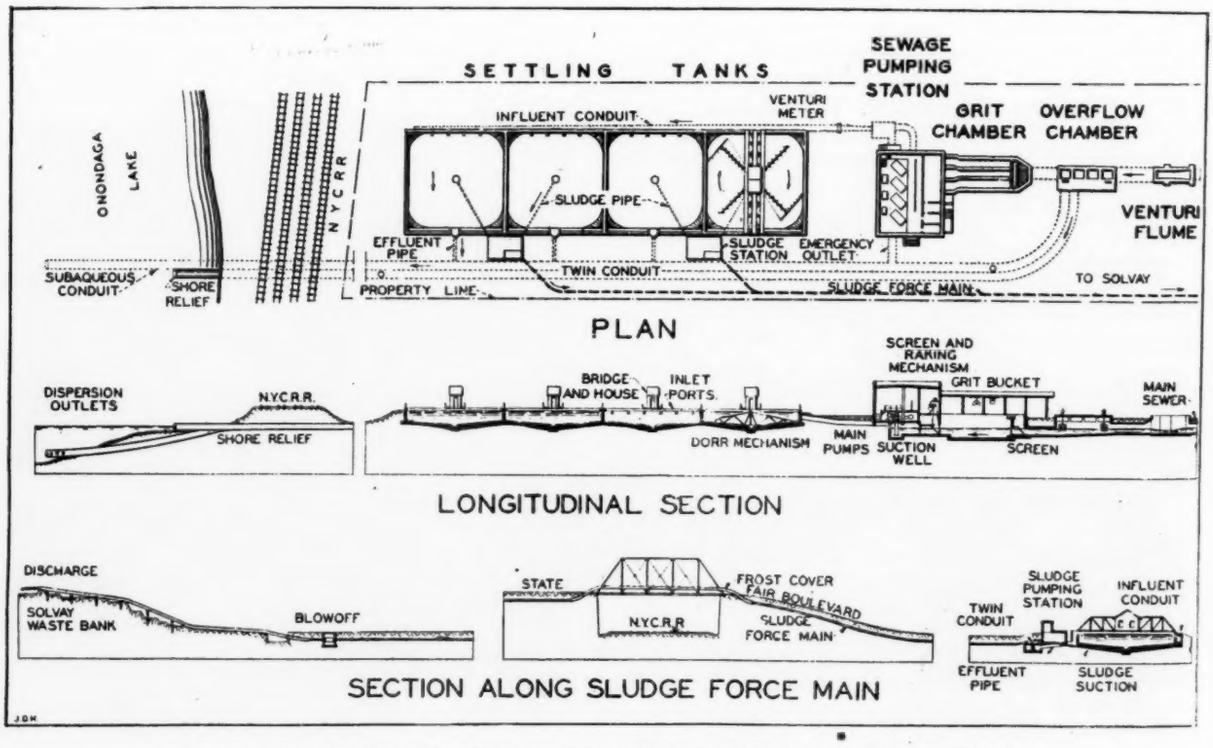
Before entering the overflow chamber, the sewage passes through a Venturi flume which has been calibrated and will be used to measure the entire flow of sewage in the intercepting sewer.

From the overflow chamber the sewage flows to the grit chamber, at the entrance of which are coarse bar screens spaced 2½ inches in the clear, for retaining large floating solids. These are hand-raked every few hours.

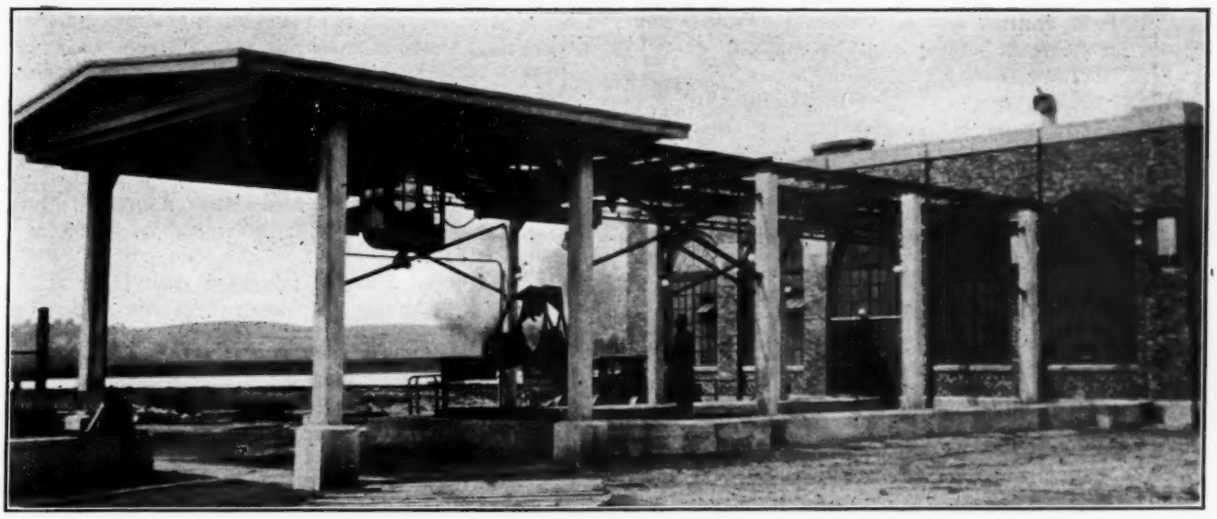
The sewage then passes through a three-compartment grit chamber, where the velocity is reduced to about one foot per second for 40 seconds. This velocity is sufficient to maintain in suspension practically all organic matters of sewage origin but permits sand and other mineral matter to settle to the bottom. The material so settling is comparatively clean, inoffensive and non-odorous. It is removed without unwatering by means of a clam-shell bucket and an electric traveling hoist operated from an overhead track system controlled by an attendant in a cab integral with the hoist equipment. This grit will be used for surfacing walks and driveways as well as for covering the screenings from the fine bar screens.

From the grit chamber the sewage passes to bar screens spaced one-half inch in the clear, the function of which is to strain out only such objects as might seriously interfere with the pumping and other treatment of the sewage. Most of the waste collected here consists of rags, cotton wastes, vegetable debris, leaves, etc. These screens are located in three compartments, each a prolongation of one of the three grit chambers.

To prevent undue accumulation of material upon these screens, which would not only interfere with the flow and cause lost head but would also screen out much organic material which it is desired to have pass into settling tanks, the screens are cleaned by mechanically propelled rakes. These are chain operated and elevate the screenings into hoppers conveniently located. The hopper bottoms are open and the contents is discharged into steel cans which, when filled, are emptied into a wheelbarrow and



GENERAL PLAN AND SECTIONS OF SYRACUSE SEWAGE TREATMENT WORKS



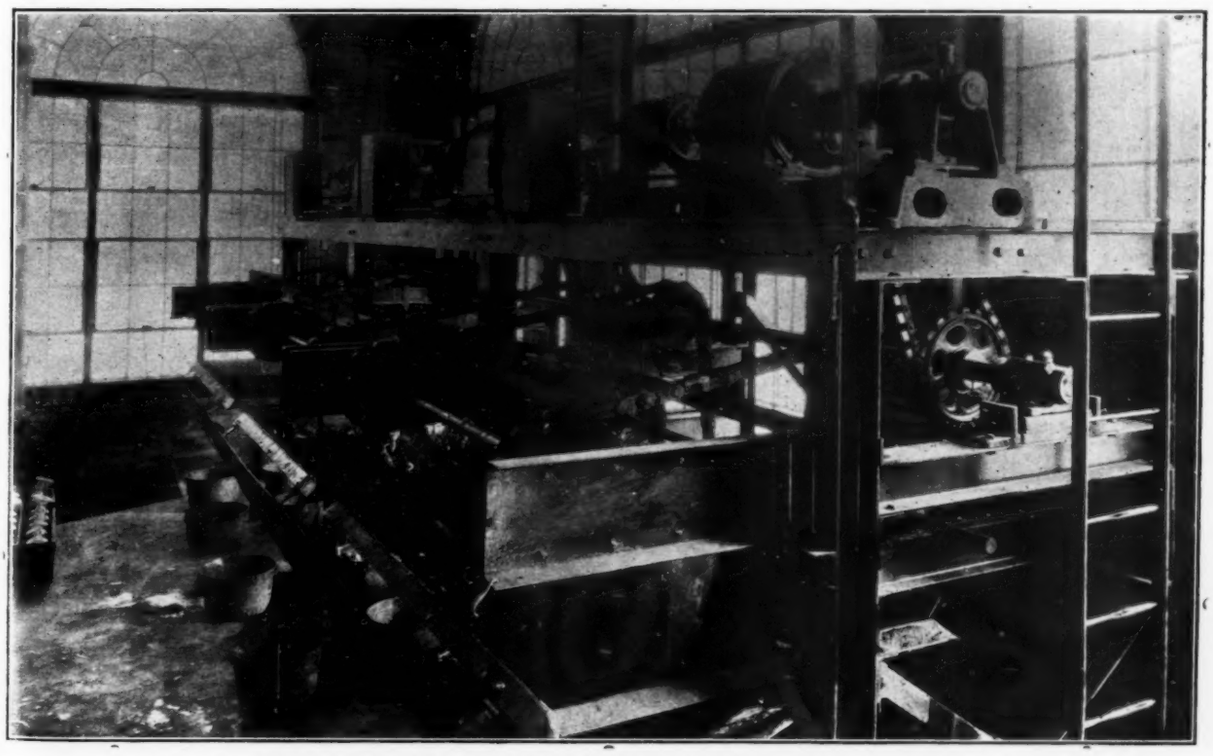
GRIT REMOVAL EQUIPMENT, SHOWING CAB AND BUCKET.

used to fill in low areas near the works, where they are covered with grit from the grit chamber. To insure that the space between bars remain practically at its full width, the mechanical rakes pass over the entire screen surface twice per minute.

After passing through the bar screens the sewage enters the suction well of the main sewage pumping station, which is located directly under the main sewage pumps. These pumps as well as the screens, control apparatus, auxiliary equipment and the various service rooms, including shop, lavatories, and laboratory, are housed in the pumping station building. There are four main pumps of the Morris 24" horizontal-shaft centrifugal type, direct connected to Westinghouse 75 h.p. slip-ring motors. The discharge pipes from the four pumps are joined into a common cast-iron force main which is 48 inches in diameter on leaving the building. Just outside the building is a 48x24 inch Venturi meter for measuring the amount of sewage pumped. This is placed in a concrete vault accessible from the pumping station and is connected to a standard indicating-recording device located on the control floor of the station.

In addition to the main pumps, there are in the pumping station two motor-operated vacuum priming pumps, either one capable of priming a 24 inch pump in about 35 seconds; also a 10 K. W. motor-generator set which produces the direct current for operating the grit cleaning mechanism; also a 6 inch sump pump for handling drainage and seepage.

On the mezzanine floor of the main pumping



SCREEN RAKING MECHANISM, SHOWING DRIVE AND HOPPERS.

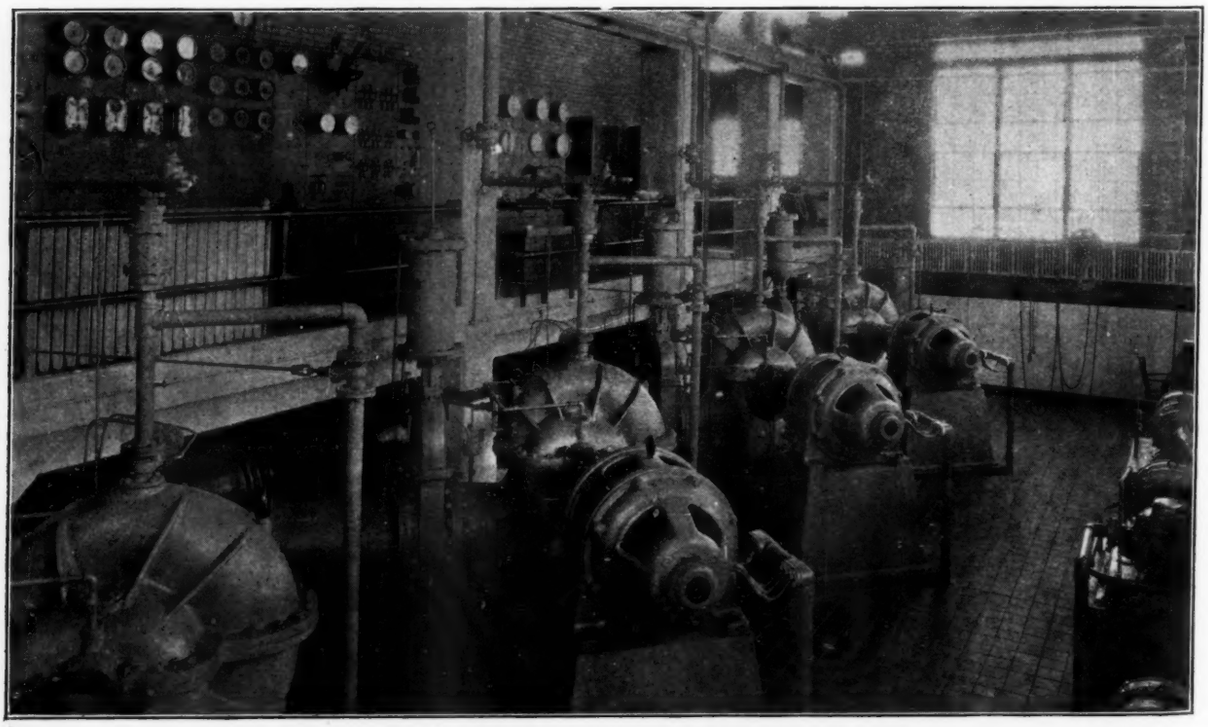
station is a control board which deserves special comment. The panels contain equipment for controlling the motors for all of the machinery employed in the treatment works; also the hydraulically operated discharge valves on the main pumps; also numerous indicating and recording gauges and supervisory operation charts. Within the compass of one board, almost 40 feet long and containing over 200 pieces of equipment and apparatus, are located the controls for the entire works. One operator serves the entire board.

After passing through the Venturi meter, the pumped sewage passes through the influent conduit to the settling tanks. The conduit is largely built integral with these tanks, of reinforced concrete, and the sewage passes from it to the tanks through twenty-four 16 inch square ports, controlled by sluice gates. The cross-section of this conduit is gradually reduced from 4'6"x4' until it reaches 18" square at the blow-off end.

There are four square settling tanks each about 71x71 ft. at the water level and about 10½ ft. deep to the center of the sloping bottom, exclusive of the small sludge cone at that point. The effective capacity of the tanks is sufficient to provide one hour detention for the average flow. The six ports for each tank are placed uniformly across one end and the entering sewage, after baffling, flows across to the outlet weir which extends the full width of the tank. From this weir an effluent channel conducts the flow to the effluent chambers, of which there is one for each tank, connected by a 30 inch cast iron pipe to an outlet pipe or deep water conduit, which carries the effluent for about one-third of a mile into the lake at which point its depth is about 25 ft. below normal lake level. This deep-water conduit begins at the overflow chamber as a by-pass and forms part of a twin conduit the other half of which is the relief sewer before referred to. The subaqueous portion of this conduit is a 60" reinforced concrete pipe. For some distance back from the outlet end it is supported on piles surrounded by a mass of protective riprap. Several 24 inch openings in the sides and end of the conduit serve to disperse the effluent over a large area and thus produce rapid mixture with the waters of Onondaga lake.

The settling tanks are provided with Dorr clarifiers, the plow blades of which are mounted upon four trussed arms suspended from a central, vertical shaft which revolves at a speed of about four revolutions per hour. These arms slowly force the deposited sludge to the central cone from which it flows through a submerged 4 inch suction pipe to the sludge pumps. Two of the four arms are equipped with articulated units, hinged and arranged to sweep the corners of the tank beyond the normal range of the radius arms. To prevent accumulation in the very corners of the tanks, these are filled with concrete, the exposed face of which was smoothly trowelled to a pitch of 1.6 on 1. The Board demonstrated several years ago in its experimental plant that high sedimentation efficiencies are obtainable with short settling periods, provided continuous sludge removal is practiced.

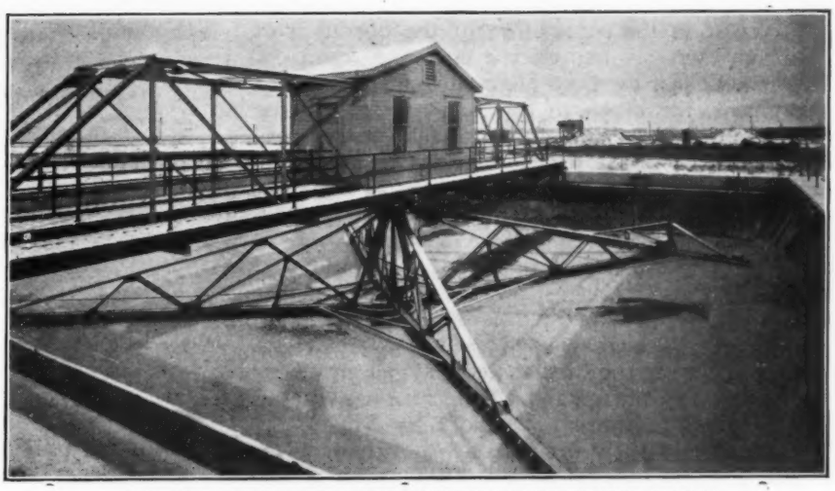
Two sludge pumping stations are provided, each serving two tanks and containing two 6x10 inch Gould triplex plunger stuff pumps. There is one pump for each tank but they are interconnected and piped to permit great flexibility of operation. They are especially designed for handling sewage sludge and are driven by Westinghouse 15 H. P. slip-ring variable-speed motors and are designed for a working pressure of 700 feet hydrostatic head. The



INTERIOR VIEW OF MAIN PUMPING STATION.

sludge pump pistons and other appropriate parts are continuously washed during service with city water furnished by a small auxiliary triplex pump at high pressure.

The 4 sludge pumps force the sludge through a 5-inch sludge force main at a distance of about 12,000 feet, where it terminates at the outlet end of the Solvay Process Company's waste pipes. The sludge force main is made of genuine wrought iron pipe, carefully coated externally with a special bituminous compound to protect it from the corrosive wastes with which most of the land here has been filled. To provide accessibility to the interior of the pipe line in the event of clogging, cast iron hatch boxes are placed at intervals of about 500 ft. and enclosed by brick chambers. Wherever the earth cover over the pipe is less than 4 feet, and wherever the pipe is exposd to the weather, it has been insulated with four layers of 1 inch hair felt, water-proofed and protected, to prevent injury to the pipe by freezing in winter during interruption of flow. The main is built of extra heavy pipe with drive-pipe couplings so that adjoining lengths butt together, thus producing a smooth bore throughout. At angle points, the pipe was specially mill bent to a radius of 10 ft. to permit the passage of sewer cleaning rods.



SLUDGE SWEEPING MECHANISM IN SETTLING TANK.

The Solvay Process Company's wastes contain spent lime, acids and industrial chemical wastes, with a volume about forty times that of the Syracuse sludge production. The unique opportunity which this offered was recognized by the Intercepting Sewer Board's engineering staff and taken advantage of through the courteous co-operation of the Solvay Company and has saved the City of Syracuse many thousands of dollars which would otherwise have been required for constructing sludge digestion and drying works, and other thousands of dollars annually for operating same. By this method of disposal the sludge is buried inconspicuously, inexpensively and inoffensively while such supernatant liquids as finally enter Onondaga lake from the waste lagoons are completely sterilized.

Before finally designing these works, the Board had constructed and operated, for more than a year, a sewage testing station in which the various types of treatment applicable to Syracuse sewage conditions were continuously under observation. It was as a result of this that the board satisfied itself as to the sufficiency of one hour sedimentation with continuous sludge removal.

One of the unusual features of this plant is the method adopted for selecting the pumps and motors. After much study the choice for motors had narrowed down between brush-shifting and slip-ring A. C. motors. The brush-shifting could give close adjustment of speed to demand and a low operating cost but was very expensive in first cost. A complicating feature was the two-charge schedule of the Syracuse Lighting Company, with bonus and penalty for power factor correction. It was finally concluded that the specifications should provide for alternative bids on both types of motors, with the provision that each bidder be required to guarantee annual current charges, these charges to be based upon an assumed hourly fluctuation in sewage volume and pumping head and upon the local power rate schedule. The bidder's price was to be equated at its annual amortized value, on the basis of 4% compound interest and 20-year serial bonds. Bids were compared on the basis of the sum of the annual amortization expense and the guaranteed annual current charges. On this basis the slip-ring motor with phase-wound rotor and grid resistance proved the most economical and was selected.

Metcalf and Eddy, in their study of the replenishment of oxygen by the re-aeration of the sewage depleted waters of Onondaga lake, estimated that about 1200 pounds of oxygen would be needed for each million gallons of sewage discharged into the lake. Samples of lake water were taken from various locations at different periods and the amount of dissolved oxygen determined, and from a thorough study of the subject it was concluded that offensive and objectionable conditions could be prevented from developing in the lake up to at least the year 1940—and possibly for some time thereafter—by sedimentation of the sewage without further treatment.

For operating the plant there are employed a superintendent, four operators, five attendants and five laborers. The operators, who are skilled electricians, are stationed in the main pumping station. The attendants, who have had power plant experience, look after the sludge pumps, the settling tank mechanisms and other machinery. The laborers attend to the screenings, the grit removal and general plant policing.

Operating schedules provide for 8-hour shifts and relief from duty every seventh day.

The total operating payroll will amount to $27,760 per year. As the design capacity of the plant is 27,500,000 gallons a day, the labor cost will be approximately $2.77 per million gallons of sewage pumped and treated.

To assist in the supervision of the operation of the plant, there are two electric operation recorders. One is a 12-pen Foxboro direct current low voltage instrument, the other an 8-pen Bristol alternating current low voltage instrument. The pens record on 7-day, 12-inch circular charts the in-and-out service of the four main sewage pumps, the three grit chamber gates, the three screen raking mechanisms, the sump pump, and the A. C.-D. C. generating set. The 8-pen unit records the operations of the four Dorr mechanisms and the four sludge pumps. Other charts give continuous records of the volume of sewage pumped and treated, the elevation of sewage in the suction well and grit chambers, the elevation of sewage above the coarse bar screens, and the pressure head on the sludge force main. Indicating gauges show the amount of vacuum in the pump priming system, the pressure heads against which each of the main pumps is discharging, the rate of sewage pumped, voltage and amperage of electrical input, and the pressure heads against which the triplex sludge pumps discharge.

CONSTRUCTORS AND ENGINEERS

The Venturi flume, overflow conduit, shore relief and effluent conduits, and sludge force main were built by Charles T. Hookway; the subaqueous conduit by the T. A. Scott Co.; the grit chamber main and sludge pumping stations and settling tanks by John Young. The Union Structural Co., Inc., built and installed the screens and screen raking mechanisms. The machinery and equipment in the main pumping station were furnished and installed by the Roberts Filter Mfg. Co. The Dorr Company fabricated and installed the cleaning mechanisms for the settling tanks, and I. N. Beeler furnished and erected the sludge pumping stations, piping and machinery.

The work of the Board was under the direction of Glenn D. Holmes, chief engineer, assisted by the following staff: J. X. Cohen, designing engineer; Girard M. Parce, Joseph D. Kieffer, Earl F. O'Brien and Earl B. Hardy, assistant engineers; Robert Yale, helper; Elva A. Wagner, stenographer; Thomas L. Webb and Samuel S. Whidden, inspectors. William P. Gyatt is superintendent of the sewage treatment works.

CONSTRUCTION COSTS LISTED IN DETAIL

The construction costs of the various elements of the sewage disposal works are given below. These costs are in part approximate, as the several structures were built under contracts that segregated the work under physically advantageous units different from the financial groupings listed below:

Storm Overflow Works	
Venturi flume	$ 4,200.00
Overflow chamber	5,000.00
Shore relief conduit	38,952.00
Total Overflow Works	$ 48,152.00
Treatment Works	
Grit chamber and pumping station	$ 74,645.00
Machinery and equipment	76,100.00
Mechanical screening equipment	18,200.00
Total Pumping Station	$168,945.00
Settling tanks	$115,032.00
Sludge removal equipment	37,987.00
Total Settling Tanks	$153,019.00
Sludge pumping stations	$ 7,822.00
Sludge pumping equipment	20,436.00
Sludge force main	64,600.00
Total Sludge Removal	$ 92,858.00
Transformer substation	$ 3,391.00
Feeder cables and conduits	1,800.00
Exterior lighting	4,919.00
Total	$ 10.110.00
Total Treatment Works	$424,932.00
Outfalls Works	
Relief conduit to lake shore	$ 38,953.00
Subaqueous conduit to deep water	66,490.00
Total Outfall Works	$105,443.00
Grand Total Sewage Disposal	$578,527.00

The population capacity of the design being 200,000, the per capita construction cost for sewage disposal is $2.90, which is a remarkably low figure especially in consideration of the "inflated" existent unit construction costs.

Obstructions and Holes in Streets and Roads

Resume of recent decisions concerning liability of municipal corporations for injuries caused by obstructions, irregularities and holes in sidewalks, streets and roads.

By John Simpson

The following article contains a resume of the recent decisions in which municipal corporations have been held liable or not liable for injuries caused by obstructions, irregularities and unguarded holes and excavations in the sidewalks and streets under their control, and for the lack of barriers where necessary. Cases concerning injuries from accumulations of snow and ice are not included, and the subject of contributory negligence of the plaintiff is not dealt with.

The New England states and a few others, as Arkansas, California, Michigan, New Jersey, South Carolina and Wisconsin, deny the liability of municipalities for such defects unless imposed by statute, and statutes of these states impose liability in varying degree, usually more restricted than the common law liability recognized in the majority of the states.

It will be noted that many cases state that a municipality must maintain its streets and sidewalks in reasonably safe condition. These statements are referred to by an authority (McQuillan, Municipal Corporations, § 2726) as "erroneus, independent of statute, if they are to be con-

strued as requiring anything more than reasonable care to keep the street and sidewalk safe. However, the statement is true in so far as it is construed as limiting the liability of the municipality and preventing it from being liable for all injuries on the streets."

OBSTRUCTIONS

A town was held liable for the death of an automobilist who, on a dark night, ran into an unlighted barrier formed by an abandoned telephone pole placed by the authorities across a highway pending the repair of a culvert swept out by a storm several days before the accident. Bennett v. Town of Wheeler, 209 App. Div. 283, 204 N. Y. Supp. 695.

A city, the Pennsylvania Supreme Court holds, Clamper v. City of Philadelphia, 124 Atl. 132, is within its rights in roping off any part of the highway deemed unsafe for travel, if the barrier is of such a nature as to be clearly visible to persons driving at night. Whether the placing of a rope across a street with its location unmarked, except by a single red light located along one side of the street near the curb 25 feet beyond the rope, was reasonable notice to travelers of the obstruction was held for the jury. One driving along the street would be justified in concluding the danger point was confined to the immediate location of the red light, but he would be bound to use reasonable precaution to discover possible barriers in the remaining part of the street.

The Kansas Supreme Court held, Petty v. City of Cimarron, 225 Pac. 1033, that where a city stretched a rope across a street to exclude travel therefrom, and a person attempted to cross the street near the rope, the city was not liable when an automobile struck the rope and caused it to strike such person, knocking her down and injuring her.

To make a municipality liable, the obstruction must be a proximate cause of the injury. A city permitted a hotel building company to pile building materials on a corner lot at the northwest corner of a street intersection. The materials covered the sidewalk on the south and on the east, and were piled so high as to cut off the view of automobiles driving south on one street and east on the other street. These obstructions to the view were negligently permitted to remain for two months after the hotel construction work had been abandoned and was not to be renewed. Plaintiff was riding south in an automobile driven by another person with alleged due care. After passing beyond the obstruction to her driver's view, her car was struck by another automobile being driven eastward on the south side of the intersection. It was held, Lambel v. City of Florence (Kan.), 222 Pac. 641, that the negligence of the city in permitting obstructions to the view to remain at the northwest corner of the street intersection and thereabout was not the proximate cause of the plaintiff's injuries, that the city's negligence only furnished one of the conditions, that the proximate cause was the collision and the incidents immediately pertaining thereto, and the city's demurrer to the plaintiff's petition was properly sustained.

A city is not negligent merely by having a pile of dirt on the street to be used in the repair of a pavement, provided it takes ordinary, usual and reasonable precautions to warn the public of such obstruction to travel. And the placing of a filled and lighted red lantern on a pile of dirt three feet long and a foot high was held a reasonable precaution to protect the public. The burden was held to rest on the plaintiff in an action for injuries to show alleged negligence in placing the lantern so that the globe became smoky and did not afford proper warning. Ferguson v. City of Des Moines (Iowa), 198 N. W. 40.

A borough which constructed a sidewalk in pursuance of an ordinance was held not liable for injury to a pedestrian who tripped on a grade stake set in the sidewalk by the borough engineer, the municipality not being liable to an individual for mere neglect in the performance of a public duty. Ausbro v. Wallace (N. J.), 126 Atl. 426.

In an action against a city and paving contractor it was held, Lampton & Burks v. Wood (Ky.), 250 S. W. 980, that evidence that a pile of stone about 4 or 4½ feet high, occupying about one-half of the driveway for 150 feet or more, protected by a warning red light at one end and an incandescent street light at the other, the latter of which was not burning, was sufficient to take to the jury the question of whether the public was sufficiently warned of the obstruction.

A town was held liable for injuries to an automobilist who collided with the concrete base of a traffic post which the town had constructed in the center of a street where the evidence showed that the upper part of the traffic post had been broken off, leaving the concrete base or abutment; that the town had no light upon or barricade around the concrete block; that the block was almost identical in color with the street, and ordinarily was marked by the light on top of the traffic post; that the accident occurred at night, when there was no such light; that there were other street lights on the four corners; and that plaintiff was driving cautiously, but did not see the obstruction in time to avoid it while passing an automobile being driven in the same direction. Town of Hobart v. Casbon (Ind. App.), 142 N. E. 138.

PERMITTING OBSTRUCTIONS

Under the principle that "any city or town council may by a temporary inclosure or obstruction of the streets, divert public travel, when same becomes necessary to meet some exigency or some laudable purpose that conserves the public or private welfare," the Arkansas Supreme Court held, Owens v. Town of Atkins, 259 S. W. 396, that the temporary grant by a town council to a school board of the right to use two streets for the length of a baseball game to be played by school children was valid, and an unauthorized interference with the right was a trespass under the Arkansas statute.

The Rhode Island Supreme Court holds, Duffney v. Clarke, 119 Atl. 370, that it was actionable negligence of a municipality which had permitted a gasoline pump to be maintained on the sidewalk, after notice that the handle of the pump was usually left attached so that it projected about 8½ inches over the sidewalk, to fail to take appropriate action for the safety of the public, and the defendant town was held liable for injury to a pedestrian who, in the dark, collided with the handle and fell.

A township has no right to permit the obstruction of a highway by the erection of a mill. United States Gypsum Co. v. Christenson (Mich.), 197 N. W. 497. Under Georgia Civil Code of 1910, section 894, a municipality cannot, without express legislative authority, grant to any person the right to erect or maintain in a public street any structure or device, such as a news stand, for his private and exclusive use. Magrill v. City of Atlanta (Ga. App.), 122 S. E. 641.

In an action for personal injuries from stumbling over a meter box in a sidewalk, the Virginia Supreme Court of Appeals held, Boush v. City of Norfolk, 117 S. E. 867, that the fact that the box was originally installed in a sidewalk by the federal government two years before the accident did not excuse the city from its duty to use reasonable care to keep the sidewalk in reasonably safe condition for pedestrians, and judgment for defendant was reversed.

IRREGULARITIES IN SURFACE

In an action for injuries to a pedestrian who struck her toe against one block of a cement sidewalk which was slightly elevated above the adjoining block, it appeared that a root or roots of a tree situated in the parking grew under two of the blocks and tipped them slightly by raising a corner of each, one to a height of 1⅜ inches above the adjoining block at the point of the accident. There was no intervening space between the blocks. It was held, City and County of Denver v. Burrows (Colo.), 227 Pac. 840, that this was a slight defect from which danger was not reasonably to be anticipated, and did not render the sidewalk unreasonably safe. The court said: "Mere irregularity and inequality of the surface of a way does not of itself make a city liable for damages sustained at such a place. A municipality is held only to the maintenance of a reasonably safe sidewalk."

The Georgia Court of Appeals holds, City of Brunswick v. Glogauer, 119 S. E. 420, that while a municipal corporation may not fail in its duty to keep its sidewalks in repair by merely permitting them to exist with certain irregularities upon the surface of the pavement, yet where there is a defect, such as, in this case, a raised and irregular surface upon the sidewalk, caused by the root of an adjacent tree growing under the sidewalk and disarranging the tiles and causing one of them to project above the level of the sidewalk, which condition has been allowed to remain for a period of years, it is a question of fact for the jury as to whether or not the city, in maintaining the sidewalk in such a condition, was negligent. On appeal, the Georgia Supreme Court, 124 S. E. 787, sustained this ruling, but reversed judgment for plaintiff on other grounds, holding that, under the facts of the case, evidence for the city showing that many other persons had safely passed over the sidewalk while in the same condition was relevant.

The Pennsylvania Supreme Court holds, Emery v. City of Pittsburgh, 119 Atl. 603, that the mere fact that a pedestrian is injured by the moving of a brick or flagstone in a sidewalk is not of itself sufficient to charge the municipality with negligence. "A municipality can be charged with constructive notice of a defect in a sidewalk only when it is of such a character as to be generally observed by pedestrians; that is, such as could and naturally would be seen by people using the walk."

A sidewalk constructed over a private driveway with a width of 38 inches, and a decline of three-eighths to one-half inch to the outer edge, where there was a sharp incline to the street level, was held not defective and the city was not liable for injuries to a pedestrian who stepped upon the incline. It was held not important that the walk was not laid strictly in accordance with the specifications. The real question was whether the walk, as it actually was constructed and existing at the time of the accident, was of such negligent construction and maintenance as to render the city liable therefor. Frisk v. City of Des Moines (Iowa), 193 N. W. 570.

It is the settled law of Florida that municipal corporations are liable in tort for failure to keep streets and sidewalks reasonably clean; and failure by a city to exercise its power, either granted by its special charter or by general statute, to require abutting owners to construct sidewalks, constitutes a breach of duty, for the consequences of which a municipality is liable. City of Lakeland v. Beck, C. C. A. 285 Fed. 375, where a verdict for plaintiff was held properly directed for injuries caused by the defective condition of a sidewalk which was shown to have been broken, uneven and in a dangerous condition, for at least a year prior to the injury, to the knowledge of the municipality.

The Missouri Supreme Court holds, Megson v. City of St. Louis, 264 S. W. 15, that the fact that the covering over an areaway was rusty, corroded and old was sufficient to put the city on enquiry as to its condition, and it could not be claimed to be a latent defect relieving the city from liability to a pedestrian who fell through the covering.

Although the owner of the premises was also liable to the pedestrian if he negligently permitted the areaway cover to become and remain in an unreasonable dangerous condition, that fact did not excuse the city for its failure to perform its undelegable duty to the plaintiff. If such owner was the primary cause of the injury he would no doubt be responsible over to the city for the damages it might be compelled to pay for his negligence.

The Ohio Supreme Court holds, Bello v. City of Cleveland, 106 Ohio St. 94, that where a dangerous condition in one of the highways of a municipality has been caused by negligent acts of an abutting property owner, resulting in injury to a person lawfully traversing the highway, and such person first pursues the abutting owner on the ground of negligence, and in settling such claim covenants to abstain from bringing any further action against him by reason of such injuries, such covenant will preclude any action against or recovery from the municipality thereafter.

The question of a city's knowledge of the presence of a defect in a street, such as the presence for 28 hours of glass strewn on a much traveled sidewalk at one of the most public places of the city, Cooper v. City of Caruthersville (Mo. App.), 264 S. W. 46, or of a slimy, mossy condition of the sidewalk caused by water flowing continuously across the pavement, not from natural causes, but from a leaky water box, City of Louisville v. Carr (Ky.), 263 Ky. 674, is usually for the jury.

(To be concluded)

Columbus Waterworks Notes

Cost of operation and pumping. Raw water of almost unprecedented hardness. Preventing deposits of carbonates.

The report of C. B. Hoover, superintendent of the Division of Water and Sewage of Columbus, Ohio, for the year 1924 shows as outstanding features of that year's work a record pumping of 8,700 million gallons; the laying of 143,000 feet of cast-iron distribution mains; installation of 800 more service connections than were ever before made in a single year; the fact that the raw water was harder than any other year but one of the seventeen years during which the softening works have been in operation and as a consequence the use of lime and soda ash totaled 10,933 tons, 2,092 tons more than ever before used in a single year; revenues from the sale of water exceeded one million dollars for the first time in the history of the waterworks; of the total revenues of $1,029,063, 45.4% was received from the semi-annual or domestic accounts, 53.4% from monthly or industrial accounts, and 1.2% from flat rate and miscellaneous sales.

The cost of operation and maintenance per million gallons treated totaled $28.09, of which $20.58 was for chemicals, $6.61 for labor and 90c. for other costs.

The cost of pumping per million gallons was $14.22, of which $7.44 was for labor, $4.40 for coal, $1.31 for electric power, and $1.07 for miscellaneous items. The average approximate lift for low service, direct service and booster service is 117 feet. During the year an average of 15.4% of the water delivered to the city from the main station was boosted into the high service.

On the basis of the water pumped to the city, the total cost per million gallons last year was $145.16, comprising the following items: Interest and annuities, $58.21; purifying and softening, $29.07; distribution, $35.06; pumping, $14.55; office, $5.38, supply, $2.55; returned water rents, $0.34. The amount pumped to the city was 8,506 million gallons.

In connection with his report on water softening and purification, Charles P. Hoover, chemist in charge, states that, as a result of experimental work conducted during several years with a view to eliminating trouble from deposits of carbonates on filter sand, meters and pipes, an inexpensive process of carbonation has been worked out.

"The process consists of adding to the softened water carbon dioxide produced by burning coke. The carbon dioxide combines with the normal carbonates in the softened water, puts them in true solution in the form of bi-carbonates so that they will not separate from the water at temperatures under boiling.

"The gas making plant will consist of six principal parts: a gas producer, a gas burner, a return tubular boiler, a steam driven air compressor, a combination scrubber and dryer and a diffuser.

"In operation, coke is burned in the gas producer, which is a closed furnace with controlled air supply furnished by a blower. The products of combustion pass from the gas producer to a gas burner, where they are mixed with air and burned to complete combustion under a boiler. The steam produced in the boiler will be used to drive the air compressor and blower so as to make a closed cycle for the process. The air compressor will take its suction from the boiler stack through a scrubber and dryer and force the washed gases through diffusers into the water to be carbonated."

Brick Paved Storm-Water Interceptor

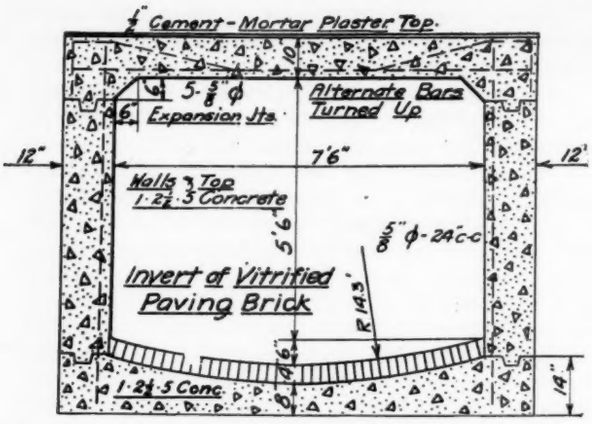
By T. W. Hacker*

Part of the problem involved in the improvement and extension of the Macon, Georgia, sewer system is the construction of a large drain for the removal of storm-water from the downtown section of the city. Macon is in a district of sudden rains of considerable volume, the topography is varied and the run-off percentage is high. Maximum volume of flow therefore reaches its peak shortly following the beginning of a downpour.

The drain is of the concrete-box type, varying in height from 5 ft. to 6 ft. and in width from 4 ft. 3 inches to 7 ft. 6 inches, the size being increased as existing drains are intercepted. The invert is laid on grades of 0.16% and 0.48%.

The large section shown by the accompanying cross-section sketch is of reinforced concrete with

*Resident Engineer, Whitman, Requardt and Smith, consulting engineers.



SECTION OF SEWER, SHOWING DETAILS OF DESIGN.

walls and top slab 12 and 10 inches thick respectively, of 1: 2: 4 mix. The invert is of plain concrete of 1: 2½: 5 mix. The size and spacing of steel reinforcing is as shown.

On account of the sand in the storm water it was determined to protect the concrete in the invert with a paving of vitrified brick. A hard, straight quality was specified to be laid in a mortar bed of one part cement and two parts sand, the joints between the brick to be filled with cement grout filler in the proportions of equal parts of cement and sand. By this form of construction an invert is provided which is smooth and highly resistant to abrasion and disintegration.

The brick used are of the 2⅝ inch vertical fiber variety, laid on edge to the 4-inch depth. The accompanying illustration shows the method of laying and the general appearance of the surface secured before the joints are filled.

The work is being done by the W. C. Howton Contracting Company of Oak Hill, Alabama, contractors, and C. L. Cartledge and Company, sub-contractors. R. C. Cowan is city engineer and the writer is resident engineer for Whitman, Requardt and Smith of Baltimore, Maryland, consulting engineers on the entire project.

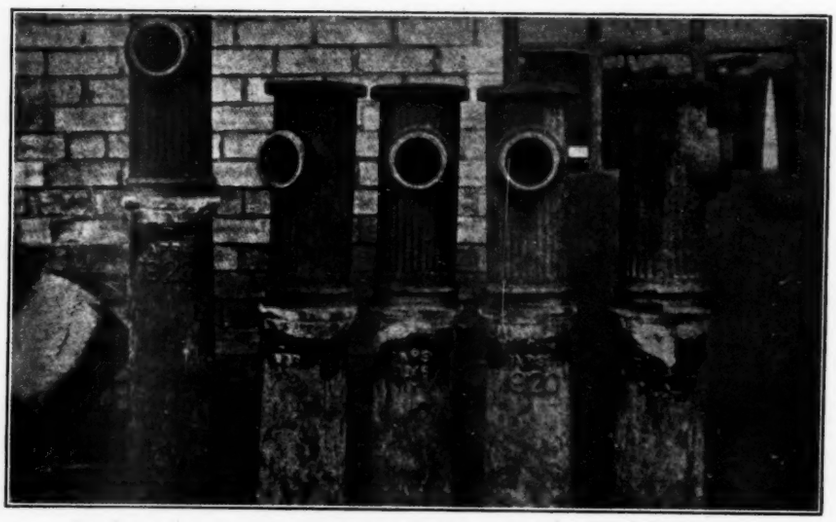
SEWER UNDER CONSTRUCTION, SHOWING BRICK INVERT.

Welding Repairs to Fire Hydrants

In his report for the year ending April 13, 1925, Thos. J. Skinker, engineer in charge of the Distribution Section of the St. Louis water works, describes as follows one of the interesting developments of the maintenance work of the division:

"There were 120 fire hydrants damaged by automobiles during the year. The cost of repairing or replacing them was $6,445.98. Bills to the amount of $4,527.98 were sent to the owners or drivers of the machines apprehended and $3,887.27 was collected, $1,918.69 of the damage was done by parties unknown.

"In order to reclaim the broken fire hydrant barrels some were cast iron welded but as this required preheating it proved rather costly. Generally it is impracticable to cast iron weld cast iron pipe larger than 4 inches in diameter without preheating as the expansion and contraction strains tend to cause cracking during and after welding. With the lower fusing temperature of tobin bronze this tendency is largely eliminated and the higher tensile strength of the bronze makes the repaired break stronger than the pipe.



BROKEN CAST IRON HYDRANT BARRELS, BRONZE WELDED

"Pieces of Class 'C' 6-inch cast iron pipe were sawed into two and the ends butted together and bronze welded. This was then broken by striking on the weld with a sledge hammer. In each instance the pipe broke before the weld. A number of fire hydrant barrels were bronze welded and have been put in service. The average cost of these welds was $2.50. The cost of a new barrel is $11.40.

"The Distribution Section is now prepared to weld in any place any split pipe and it is expected by so doing to effect a material saving in repairs.

"The Department intends to use many of the short pieces of pipe now thrown into the scrap pile in the making of special fittings such as tees, crosses and bends."

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State Regulation of Treatment Plant Operation

Sewage treatment has made great strides in this country during the past ten years, to judge by the *number of plants* that have been built; but in some other respects the condition is not so satisfactory. Some states are abundantly provided, but in other states not more than two or three plants are known of by the state health officials. Fully as important is the fact that a large percentage of the plants are not being so operated as to produce efficient results. Some are even public nuisances and a few have been frankly abandoned.

As illustrations of the uneven distribution of treatment plants, New Jersey in the east contains 158 municipal plants and Texas in the west 198 plants. But Oregon contains but six plants, Idaho two, Vermont no municipal plants and Maine but one.

A sewage treatment plant is usually installed to protect from nuisance or harm communities, individuals or enterprises that have no part in the operation or finances of the plant. It naturally results in many cases that the trouble and expense of operating the plant efficiently and keeping its capacity up to the requirements of the increasing volume of sewage are shirked by those in charge of the plant unless they are constrained by some authority.

If a plant is built at considerable expense and its operation is afterward neglected, not only is the money invested in it wasted, but a false sense of security may exist and real improvement of unsanitary and dangerous conditions be frustrated.

It is of little avail for a legislature to give a state board power to require a municipality to construct a sewage treatment plant, but none to require its proper operation. And with the power should go sufficient funds to provide the salaries and traveling expenses of competent inspectors who will keep informed as to the actual operating conditions of every plant in the state and be able to give helpful advice for meeting difficulties that may arise.

A few states do this, but many more do not. A majority of the state health boards have informed us that they do not know how the treatment plants in their respective states are operating, but they think the operation is far from satisfactory in most cases.

More than a thousand plants, costing many millions of dollars, have been built by municipalities under compulsion from the state. Perhaps half of these are performing very inadequately or not at all the functions for which they were constructed, and the cost of them might just as well have been saved to the cities.

State health boards, sanitary engineers and others officially concerned with public sanitation should feel it a duty to bring this matter forcibly to the attention of their state legislatures, impressing upon them that, unless sewage treatment plants are to be controlled in their operation, the construction of them is largely a waste of public money.

Extent of Sewerage in Cities

In the larger cities and especially in the older states, sewerage is so commonplace that probably nearly every citizen believes, as a matter of course, that all of the houses in his city are connected to the municipal sewerage system. As a

matter of fact, there are probably not a dozen cities in the country—perhaps none—of which this is true. In almost every city there are certain outlying sections where the houses are scattered and to which no sewer has as yet been extended. In addition to that, there are built-up sections in many cities in which no sewers have been constructed for one reason or another, in some cases because a small area here and there is too small to drain by gravity into the general sewerage system; in other cases because it is believed or assumed that, on account of the poor character of the houses and poverty of the inmates, no connections would be made with the sewers if they were built. This is the case in the negro section of a number of southern cities.

This, of course, introduces the problem of a satisfactory substitute for sewers, which will be discussed in an article in a later issue based upon information obtained from several hundred questionnaires sent out by PUBLIC WORKS. It suffices to say here that none of these substitutes is as satisfactory as a reasonably good sewer system.

Each city was asked to state approximately the percentage of residences within its limits that were connected with the sewerage system. Examining these reports by states, we find there are very few cities claiming that all of the houses are so connected; and in some cases where this claim is made, we believe that the intention was to indicate that this percentage applied to those houses to which a sewer was accessible and not to outlying sections not yet sewered.

Averaging these reports by states, we find three states with averages between 50 and 60 percent, while half the states fall within the limits of 60 and 80 percent.

In the case of several states, the number of cities reporting was perhaps not sufficient to give a fair average; but if we eliminate these and take only those where the number of cities reporting is fairly large, we find one, Missouri, reporting less than 70 percent; seven, Illinois, Indiana, Iowa, Michigan, Pennsylvania, Texas and Wisconsin, between 70 and 79 percent; Massachusetts, New Jersey and Ohio, between 80 and 89 percent; and California and New York over 90 percent. Ohio's average is 81 percent, so that it can practically be grouped with Illinois, Indiana, Iowa, Michigan and Wisconsin, apparently showing geographical influence. Although only one state is given below 70 percent, the others showing as low a percentage but from which a small number of reports were received, were all southern or south central states, except one.

It can hardly be expected, nor would it be justifiable, that every city would make a hard and fast rule that a sewer connection would be furnished for every building even though a half mile or more of sewer would need to be built for this one connection. However, where only 50 to 70 percent of the buildings are connected, an improvement in conditions is certainly possible without any excessive expenditure for sewer per connection made possible thereby. Where sections are too low for gravity drainage, pumping can now be employed with the assurance that it will operate satisfactorily and at a moderate expense. In the case of the homes of negroes, foreign laborers, or others who might not willingly make connections to a sewer, ordinances should be adopted requiring landlords or other owners to connect all residences to sewers where they are accessible. In order to render the cost burden of this as light as possible upon the owner, the plan adopted by Baltimore and a few other cities might well be followed of having the city make the connection or bear the cost thereof, and collect the amount in five or more annual payments in connection with the tax collections, the amount being made a lien upon the property.

Much study has been given to the subject of substitutes for sewers by the United States Bureau of Public Health as well as by sanitary engineers connected with municipalities or in private practice, and considerable improvement in that respect has been developed during the past few years. However, in safety, convenience and cost, all of these fall far short of a reasonably good sewerage system and until such a system has been built no city, we believe, should feel satisfied with its treatment of the problem.

Leaks in Cambridge Watermains

The Water Bureau of Cambridge, Mass., had a pitometer survey made of the entire distribution system in 1925 and reports that since then the leakage in the mains has been very small. In 1921, 24 leaks were found in mains, 6 in hydrants and 5 in valves. In 1922 the leaks found were 20 in mains, 7 in hydrants and 11 in valves. In 1923 the leaks were 17, 4 and 9 respectively; and in 1924 there were 26, 5 and 7 respectively.

New Highway Engineering Fellowship

The National Slag Association has established a fellowship in Highway Engineering at the University of Michigan, to provide for the investigation of an approved subject relative to the utilization of blast furnace slag in the construction and maintenance of roads and pavements.

Brass Services in Connecticut

The Public Utilities Commission of the State of Connecticut has recently amended the code of regulations relative to water services by establishing a smaller minimum size for services where brass pipe is used. The reason for this is believed to be that the interior diameter of brass pipe is maintained practically undiminished by scale or rust throughout the life of the pipe.

Much of the water supplied through public water systems in the State of Connecticut is such as to make the use of brass or lead pipe for services very desirable. This amendment to the code will probably result in an increase in the use of brass pipe in that state. Reference was recently made in PUBLIC WORKS to the extensive use of this pipe by the Hackensack Water Company.

Data from State Health Boards

Cities operating sewage treatment plants, kinds of plants used, capacity, effectiveness, and other information relative to the subject, furnished by officials of state health departments.

The State Health Boards or other health officials of most of the states have kindly furnished us with lists of the cities where there are sewage disposal plants, and in several cases have furnished in addition, general information on the subject. We asked them to give us what information they could concerning the efficiency with which the plants are operated, but most of them confessed very little information on the subject.

The State Board of Health of North Carolina, according to G. F. Catlett, principal assistant engineer, "has never been able to collect accurate and specific data of most of these plants but does know that most of them are very poorly operated. North Carolina is a state of small towns with no very large cities or congested communities. For this reason the sewage disposal problem has not been as serious a one as is the case in most of the other states. Where a disposal plant is put in to protect the public water supply, we have gone more carefully into the design and operation, but even in such cases, we have had no great load upon our purification plants compared to that existing in some other localities. Most of our sewage treatment works have been installed by the small towns in order to protect them from suits originating from nuisances. As would be expected where an installation is made to benefit another community, there is great difficulty in getting the municipality to spend the necessary funds for proper effective operation. We have recently secured an appropriation and are now engaged in laying out a program for more complete control of sewage disposal plants and hope a little later to have more complete information in regard to their efficiency."

Where the number of disposal plants in a state warranted it, the information furnished has been tabulated and will be published in this and following issues. Where there are few plants, or where the officials have given us special information, such information is contained in the following paragraphs:

MAINE

Maine has only one municipal sewage treatment plant and Elmer W. Campbell, Director, Division of Sanitary Engineering, says that it has been in operation about a year and is giving fair results removing a considerable percentage of the sludge, and that it receives very little attention.

KENTUCKY

Concerning the eighteen Kentucky plants, F. C. Dugan, director of the Board of Sanitary Engineering, reports that efficiency tests have been made of only two of them. At Lexington the relative stability of the effluent was found to be 95, while at Wilmore the relative stability was 20.

VIRGINIA

Richard Messer, chief engineer of Virginia State Board of Health, states: "Owing to limited personnel in our department, we are unable to keep as close check on efficiency of operation of sewage plants as we would like. Our various inspections, however, have indicated that the plants all work satisfactorily where they are given the proper amount of personal attention."

MASSACHUSETTS

Massachusetts is one of the states which keeps in close touch with the operation of the sewage treatment plants of its cities. X. H. Goodnough, chief engineer of the Department of Public Health, commenting upon information given in a report for the year 1923 (the latest yet available), states that while the sand filters at Andover appear from the report to be practically worthless, it is only fair to say that they were at that time about to be abandoned and have since been replaced by a new system with an outlet in the Merrimac river. "A new system of sewage disposal for the treatment of the sewage of Worcester by means of Imhoff tanks and trickling filters is to be put in operation within the next few days. (Written June 22nd.) The sand filter beds will still be used for the treatment of the excess flow at times of storm."

DELAWARE

In Delaware there are two municipal plants as shown in the table, in addition to which five institutional plants also are reported by R. C. Beckett, state sanitary engineer. A new plant has been built for the Brandywine Sanitarium at Brandywine Springs for two hundred persons, consisting of a septic tank, sprinkling filters and chlorination of the filter effluent. At the Girls' Industrial School at Claymont there is an installation for 150 persons, consisting of Imhoff tanks, sprinkling filter, secondary settling basin and sludge beds. At Farnhurst is a plant taking care of about 500 people, consisting of an Imhoff tank with effluent discharging into a small stream. At the Home for Feeble Minded at Stockley, an Imhoff tank is provided for a population of 200, followed by subsurface irrigation in very coarse sandy soil. At the Colored Industrial School at Marshallton, about 100 inmates are served by a small septic tank followed by subsurface irrigation. In each of the last two a siphon is used for dosing the irrigation bed.

NORTH DAKOTA.

A. A. Whittemore, State Health Officer of North Dakota, informs us that, so far as is known to the Department of Public Health

(which is only two years old), only three cities have sewage treatment plants—Fargo, Grand Forks and Minot. There should be plants in many more cities, especially those located on the Red, James, Cheyenne, Mouse and Missouri rivers.

IDAHO

The State sanitary engineer of Idaho, W. V. Leonard states that there is no state law prohibiting pollution of Idaho streams by sewage, but the Department of Public Welfare is endeavoring to have placed on the statutes a law requiring the sterilization of domestic sewage before discharging it into any stream. The Department knows of only two purification plants in the state, which use septic tanks and chlorine sterilization.

OREGON

State health officer Frederick D. Stricker states that in Oregon the only municipal treatment plants are at Pendleton, Bend, La Grande, Mt. Angel, Dallas and Monmouth. These plants consist of Imhoff tanks only and are not entirely satisfactory.

LOUISIANA

The sewage treatment plants in Louisiana are as follows, according to information furnished by John H. O'Neill, sanitary engineer of the State Board of Health: Bastrop—septic tank; Cedar Grove—Imhoff tank and contact bed; De-Ridder—Imhoff tank and sprinkling filters; Hammond—Imhoff tanks and sprinkling filters; Lake Charles—Septic tanks; Lafayette—Imhoff tanks and contact beds; New Iberia—septic tanks and contact beds; Ponchatoula—Imhoff tank and sprinkling filters; Ruston—septic tank and contact bed; Winnfield—Imhoff tank and sprinkling filters.

WISCONSIN

The Bureau of Sanitary Engineering of the State Board of Health of Wisconsin sends us a list of municipalities the sewage of which is treated, but without specifying the kind of treatment given the sewage. Of the 490 municipalities in the state, 192 are provided with both waterworks and sewerage and 9 with sewers only, or 201 have sewerage systems, of which the 79 in the list below, or nearly 40%, treat the sewage in some way.

Amery, Antigo, Athens, Augusta, Beaver Dam, Belgium, Beloit (in part only), Boscobel, Brillion, Burlington (in part only), Cashton, Cedarburg, Chilton, Clinton, Columbus, Cumberland, DeForest, Delavan, Denmark, Edgerton, Elkhart Lake, Elkhorn, Ellsworth, Elmwood, Evansville, Florence, Fond du Lac, Genoa Junction, Glidden, Hartford, Hillsboro, Horicon, Iron River, Jackson, Johnson Creek, Kewaskum, Kimberly, La Farge, Lake Geneva, Lake Mills, Lancaster, Madison, Marshfield, Mayville, Milton, Milwaukee, Monroe, Monticello, Mount Goreb, Mukwonago, New Glarus, New Lisbon, North Milwaukee, Oconomowoc, Platteville, Plymouth, Portage, Port Washington (in part only), Randolph, Reeseville, Ripon, Sheboygan Falls, Spooner, Stoughton, Sturtevant (Corliss), Sun Prairie, Thorp, Tomah, Union Grove, Viroqua, Waterloo, Waukesha, Waupaca, Waupun, Wauwatosa, West Allis, West Bend, West Salem, Whitewater.

Sewage Disposal Plants in New York State

Information furnished by Charles A. Holmquist, Director, Division of Sanitation, State Department of Health.

Location	Plant	Population
Albany	Pumping, Imhoff tank and sludge bed	100,000
Albion	Imhoff tanks & contact sludge beds	4,500
Altamont	Imhoff sprinkling filter and chlorination	700
Auburn (2 plants)	Septic tank and contact beds	7,472 out of 34,668
Avon	Settling tank	2,050
Ballston Spa	Septic tank and contact beds	4,138
Batavia	Settling tank & sprinkling filters	11,600
Beacon	Septic tank and contact bed	6,600 out of 12,000
Brewster	Chemical disinfection and filtration	500 out of 1,296
Brighton Sewer District No. 1	Pump, screen grit chamber, 4 contact beds & sludge bed	5,000
Briarcliff Manor	Septic tank and sand filters	980
Brockport	Screen chamber, Imhoff tank & sprinkling filter	3,569
Canandaigua	Imhoff tanks, sludge beds	7,000
Cheektowaga Town (S. W. portion)	Contact beds	1,000
Coney Island, N. Y. City (3 plants)	Chemical precipitation	.....
Corinth	Septic tank	2,166
Dansville	Septic tank and contact beds	3,936
Depew	Septic tank and contact bed & wave bed	3,931
Dolgeville	Septic tank	2,685
East Aurora	Septic tanks, contact bed and sludge bed	2,781
East Rochester	Screening and grit chamber	2,398
East Syracuse	Septic tank	327
Eastwood (2 plts)	Imhoff tank & sprinkling filters	1,400
Elmhurst, N. Y. C.	Chemical precipitation, Septic tank & sand filters	.....
Fairport	Grit chamber, screen chamber, settling tank & sludge bed	3,112
Far Rockaway, N. Y. City	Chemical precipitation	.....
Frankfort	Screen chamber, Imhoff tank & sludge beds	3,303
Franklinville	Settling tank, Broad irrigation & sludge beds	1,568
Fulton	Septic tank	2,765 out of 12,000
Fultonville	Septic tank	812
Garden City	Settling tank & sand filters	.....
Glen Cove	Imhoff tanks & chlorination sludge beds	8,500
Gloversville	Settling tanks, sprinkling filters, sand filters	20,500
Goshen	Imhoff tank, dosing tank, sand filters & sludge bed	3,511
Great Neck Estates.	.....	.....
Greene (private system)	Septic tanks	200
Harrison Town (District No. 1)	Screen, Imhoff tank, sprinkling filter, secondary settling tank, sterilization & sludge	2,500
Haverstraw	Screening	5,669
Hempstead	Septic tank and sand filters	5,000
Highland Falls	Two septic tanks	3,000
Hobart	Settling tank, sand filters and sludge bed	544
Holley	Ihmoff tank, dosing tank, sprinkling filter & sludge bed, Imhoff tank	1,650

Sewage Disposal Plants in New York State—Continued

Location	Plant	Population
Huntington	Imhoff tank, storage tank, sterilization and sludge bed	3,000
Irondequoit (Summerville Sewer District)	Screen, settling tank & sprinkling filters	1,000 14,802
Ithaca	Septic tank	.....
Jamaica, N. Y. C.	Chemical	
Kingston	Septic tank and contact beds	3,939 out of 25,908
Kirkland, Town Hamilton College Sewer District	Imhoff tank & sludge bed	500
Lackawanna	Septic tank and contact bed	14,549
Lake Placid	Septic tank and sand filters	1,682
Lancaster	Septic tank and contact beds	14,549
Larchmont	Imhoff tanks, sludge beds	2,500
Liberty	Septic tank and contact beds	2,072
Lyons	Pumping, Imhoff tank, screen sprinkling filter and sludge bed	4,500
Long Beach	Settling, disinfection & storage for tide	200-1,500
Mamaroneck	Activated sludge	6,500
Middleport	Imhoff tank, sprinkling filter & sludge bed	1,530
Monticello	Septic tank, contact bed & sand filter	1,941
Mt. Kisco	Septic tanks & contact beds & sand filters	2,800
Mt. Morris (two plants)	Imhoff tank & sludge beds	3,884
Mt. Vernon	Septic tanks and sprinkling filters	28,200 out of 34,500
Newark	Imhoff tank, sprinkl'g filter & sludge bed pumping	7,500
New Hartford Village & Sewer District No. 1	Settling tanks and sludge beds	2,200
New Lots, East N. Y. City	Chemical precipitation	.....
New Rochelle	Dorco screens	40,000
New York City	.....	5,000,000
North Hempstead Great Neck Sewer District	Settling tanks, disinfection & sludge bed	2,000
Ocean Beach	Imhoff tank and chlorination	800
Olean (2 plants)	Septic tanks and sprinkling filters	1,500 out of 14,748
Oneida	Settling tank, sludge digestion tanks, sludge drying beds	8,000
Ossining	Coarse screens	10,000
Oyster Bay	Main plant — Imhoff tank, sand filter and	
Glen Cove Sewer District	sludge bed	4,000 out of 6,000
Oswego, West Side	Imhoff tank and sterilization	in use Feb. 26'16
Painted Post	Imhoff tanks, sludge drying beds	2,000
Palatine Bridge	Settling	392
Peekskill	Two settling tanks for part of village	100 & 400 out of 15,245
Pelham, Pelham Manor, North Pelham	Settling tank and sprinkling filters	5,000
Penn Yan	Settling tank & contact bed	4,579
Pleasantville	Settling tank, double contact beds, sand filters, sludge beds	4,000
Port Chester	Pumping, Imhoff tank	15,000
Port Washington	Imhoff tanks & chlorination	.....
Ravena	Imhoff tanks & sludge bed	1,700
Rochester (main plant)	Grit & screen chambers, Imhoff tanks & sludge beds	250,000
Rochester (Brighton plant)	Imhoff sprinkling filters & final settling tanks	10,000
Rochester (Charlotte plant)	Imhoff tanks, sludge beds	.....
Rye	Settling tank and sprinkling filter	3,964
Saratoga Springs	Septic tank and sand filters	12,683
Saugerties	Septic tank (3 plants)	3,929
Schenectady	Imhoff tanks, sprinkling filters, sludge beds & pumping plant	72,826
Scotia	Coarse screens	3,000
Seneca Falls	Settling tank & sludge bed	6,588
Sharon Springs	Septic tank & spring filter	530 to 2,500
South Glenns Falls	Screen and settling tanks	2,247
Stamford	Settling tank	1,000 to 3,000
Skaneateles	Settling tank	1,615
Suffern	Imhoff tank, sterilization pumping and two sludge beds	700 out of 2,781
Syracuse	Settling tanks of the Dorr type	175,000
Tuxedo Park	Septic tank & percolating filter	3,000
Wappinger Falls	Imhoff tank & sludge bed	.....
Waterloo	Imhoff tank & sludge bed	3,921
Westfield	Septic tanks & contact beds & sludge beds	2,985
Yonkers	Grit & screen chamber and pumping	2,500 out of 79,803
Yorkville	Septic tank	691
Youngstown	Imhoff tank & chlorination	600

Tabulated Sewerage Statistics

Sewage treatment plants in several hundred cities, with details of construction and operation. Percentages of residences sewered. Pumping plants and amount of sewage pumped.

The information collected during the past few weeks for our annual sewerage statistical number deals chiefly with sewage treatment plants, although there are a few facts and figures concerning other sewerage matters. The latter are tabulated in the table immediately following and give, for several hundred cities, the percentage of residences connected with the sewers, the amount of sewage, the amount pumped and kind of pumping equipment, and the body of water into which the sewage is discharged. A synopsis of some of these items is given elsewhere in this issue.

Through the courtesy of health officials of the various states we have obtained lists of sewage treatment plants which are believed to be complete for most of the states. Lack of space necessitates postponing publication of many of these lists to later issues. From city officials we have obtained data concerning such plants in several hundred cities, these including kind of tank (or other preliminary treatment), detention period, percentage of solids removed, reduction in consumption of dissolved oxygen; kind of filters area and depth, and reduction effected in suspended matter and consumption of dissolved

Sewerage Connections, Amounts and Pumping

City	Percentage of residences connected to sewers	Sewage discharged into	Average amt of sewage per day, gals.	Amt. of sewage pumped	Kind of pump and power used
Alabama:					
Gadsden	85	River	....	....	....
Selma	60	River	....	....	....
Sheffield	60	....	....	....	....
Troy	75	....	....	....	....
Arizona:					
Douglas	100	River	37,600	....	....
Arkansas:					
Blytherville	75	Bayou	....	....	....
California:					....
Alameda	100	Estuary	1,000,000	....	
Chico	50	None—irrigation	....	....	....
Fresno	99	Irrigation	8,000,000	....	....
Modesto	97	River	1,500,000	....	....
Napa	98	River (tide wat.)	800,000	....	....
Ontario	—	Cesspools	600,000	....	....
Redlands	80	....	1,200,000	....	
Sacramento	100	River	18,000,000	All	Sev. kinds of steam & elec.
San Leandro	100	San Fran. Bay	100,000	....	....
Santa Maria	95	Pacific Ocean	2,200,000	All	Centrif-elec.
Santa Rosa & some outside	All	Creek; then into river	1,250,000	....	....
Vallejo	99	River	....	....	....
Venice	90	Pacific Ocean	2,000,000	All	Byron Jackson-elec.
		None—irrigation			
Visalia	99		1,000,000	....	....
Watsonville	100	River	800,000	....	....
Colorado:					
Colorado Sps.	95	Creek	4,500,000	....	....
Denver	90	River	46,395,800	....	....
Gd. Junction	96	River	2,000,000	....	....
Montrose	90	River	....	....	....
Pueblo	92	....	....	....	....
Sterling	100	River	2,000,000	....	....
Connecticut:					
Ansonia	93	River	....	....	....
Bridgeport	90	Long Is. Sound	25,000,000	5,000,000	Centri.-elec.
Derby	80	River	....	....	....
Hartford	prac. all	River	....	....	Centri.-elec.
Middletown	50	River	10,000,000	....	....
New Haven	75	Tidal estuary of Long Isl. Sound	30,000,000	....	....
Putnam	80	River	50,000	5 per. ct.	Centri.-elec.
Wallingford	95	River	1,600,000	....	....
Delaware:					
Wilmington	95	Rivers	16,000,000	....	....
Florida:					
Fernandina	54	Sound (arm of ocean & tidal)	70,000	....	....
Jacksonville	70	River	7,000,000	3,000,000	Yeomans-elec.
Lakeland	30	Lake	....	....	....
St. Augustine	50	Rivers	....	None	....
St. Petersburg	60	Bay	3,000,000	....	....
Sanford	70	Lake	350,000	....	....
Georgia:					
Americus	80	Small river	....	....	....
Cordele	50	Creek	....	....	....
Moultrie	85	Creek	....	....	....
Rome	85	River	....	....	....
Idaho:					
Coeur d' Alene	40	River	250,000	....	....
Idaho Falls	80	River	1,200,000	....	....
Illinois:					
Beardstown	90	River	....	....	....
Benton	80	River	....	....	....

City	Percentage of residences connected to sewers	Sewage discharged into	Average amount of sewage per day, gals.	Amount of sewage pumped	Kind of pump and power used
Maryland:					
Hagerstown	75	Creek	2,000,000	....	....
Salisbury	30	River	400,000	....	....
Massachusetts:					
Andover	75	River	1,000,000	All	....
Brockton	90	....	3,200,000	All	Centri., elec.
Brookline	98	Met. sewer	....	4,000	Rotary, elec.
Fall River	..	River and bay	....	....	....
Fitchburg	90	River	3,500,000	5 per ct.	Centri., elec.
Great Barrington	90	River	....	....	....
Haverhill	80	River	....	....	....
Holyoke	100	River	....	....	....
Lowell	90	River	....	....	....
Lynn	66	Harbor	....	....	....
Malden	80	Met. sewer	....	....	....
Medford	90	Met. sewer	....	....	....
Milton	56	Harbor	390,000	25,000	Centri., elec.
New Bedford	90	Ocean	10,000,000	10 per ct.	Electricity
Peabody	90	Ocean	4,250,000	All	Centri., elec.
Taunton	75	River	1,000,000	....	....
Watertown	95	Met. sewer	....	....	....
Worcester	90	River	22,500,000	....	Centri., elec.
Michigan:					
Albion	85	River	400,000	....	....
Ann Arbor	97	River	5,000,000	....	....
Battle Creek	65	River	6,000,000	....	....
Bay City	75	River	....	....	....
Coldwater	50	River	....	....	....
Detroit	85	River	130,000,000	15,000,000	Vert. centrifugal, stm. & el.
Dowagiac	40	River	100,000	....	....
Flint	75	River	20,000,000	1,000,000	Ejectors, elec.
Hamtramck	98	River	....	....	....
Hastings	50	River	....	....	....
Holland	75	River and lake	1,250,000	10 per ct.	Centri., elec.
Ironwood	90	River	....	....	....
Jackson	90	River	....	None now	....
Kalamazoo	90	River	6,290,000	720,000	Centri., elec.
Midland	55	River	....	....	....
Niles	50	River	....	....	....
Owosso	75	River	....	....	....
Traverse City	90	Bay	....	....	....
Minnesota:					
Albert Lee	80	Lake	1,000,000	....	....
Austin	90	River	2,000,000	....	....
Cloquet	75	River	....	....	....
Faribault	70	River	430,000	144,000	Ejector, elec.
Little Falls	60	River	200,000	....	....
New Ulm	60	River	....	....	....
Red Wing	70	River	6,000	....	....
Rochester	70	River	2,000,000	5 per ct.	Ejec., elec.
St. Cloud	60	River	....	....	....
Stillwater	65	River	....	....	....
Virginia	100	Creek near lake	900,000	1 per ct.	Centri., elec.
Mississippi:					
Clarksdale	95	River	400,000	....	....
Columbus	60	River	....	....	....
Gulfport	5	Gulf of Mexico	....	....	....
Yazoo City	80	River	....	....	Centri., elec.
Missouri:					
Clinton	33	Creek	....	....	....
Columbia	..	Small creek	....	....	....
Fulton	60	Creek	200,000	....	....
Hannibal	60	River	....	....	....
Independence	80	....	....	20 per ct.	Ejector, elec.

Canton	40	Creek	500,000	....	....	
East St. Louis	85	River	25,000,000	All when river high	Centri., gas engine	
Edwardsville	66	Creek	300,000	....	....	
Evanston	98	Chicago Dr. Can.	....	....	....	
Granite City	90	River	11,000,000	All	Am. Well Wk., electric	
Joliet	95	River	75,000	....	....	
Kewanee	50	Small creek	1,000,00	....	....	
Marion	35	Small streams	200,000	....	....	
Monmouth	35	Creek	600,000	....	....	
Oak Park	100	Chicago Dr. Can.	4,000,000	....	....	
Pekin	50	River	....	....	....	
Rockford	90	River	7,000,000	....	....	
Waukegan	75	Lake	7,000,000	....	....	
West Frankfort	35	Small river	400,000	....	....	
Wilmette	—	Drainage canal	....	....	....	
Winnetka	100	Drainage canal	1,000,000	6,000	Shone ejectors	
Indiana:						
Elkhart	80	Rivers	....	....	....	
Frankfort	75	Small creek	....	....	....	
Jeffersonville	50	River	....	....	....	
Kendallville	90	Lake	....	20 per ct.	Centri-elec.	
Lafayette	75	River	....	....	....	
La Porte	60	Ditch to river	8,000,000	....	....	
Portland	50	River	....	....	....	
Princeton	60	Creek	1,000,000	....	....	
Richmond	95	River	....	....	....	
Rushville	90	River	250,000	....	....	
Shelbyville	35	River	....	....	....	
South Bend	85	River	....	....	....	
Vincennes	75	River	600,000	None at present	Electricity	
Wabash	60	River	2,000,000	....	....	
Warsaw	85	River	125,000	1,000	Shone ejector, electricity	
Iowa:						
Ames	90	River	600,000	All	Open runner, vertical centri.; elec.	
Atlantic	80	River	....	5 per ct.	Centri., elec.	
Boone	90	River	1,500,000	....	....	
Centerville	67	Very small strms.	350,000	....	....	
Cherokee	80	River	....	....	....	
Clinton	75	River	3,500,000	....	Consider. one	
Creston	50	River (dry in sum.)	300,000	....	....	
Fort Dodge	75	River	1,000,000	15 per ct.	Electricity	
Keokuk	75	River	....	....	....	
Oelwein	60	Creek	600,000	....	....	
Red Oak	90	River	400,000	....	....	
Waterloo	75	River	36,500	....	Centri.-elec.	
Kansas:						
Hutchinson	80	River	....	....	Am. & F.-M.; elec.	
Iola	100	Creek	....	....	Electricity	
Ottawa	60	River	400,000	....	....	
Wichita	90	River	....	85,000	Centri.-elec.	
Kentucky:						
Ashland	70	River	....	....	....	
Covington	70	River	....	....	....	
Dayton	80	River	....	....	....	
Ft. Thomas	10	River	....	....	....	
Henderson	75	River	500,000	25 per ct.	Electricity	
Owensboro	70	River	1,000,000	....	....	
Paducah	90	River	....	....	....	
Louisiana:						
Alexandria	90	River	....	All during high water	Electricity	
Lafayette	25	Bayou	350,000	All during high water	Fair.-Morse, electricity	
New Orleans	93	River	50,000,000	All	Centri., elec.	
Maine:						
Augusta	95	River	1,000,000	....	....	
Bangor	98	River, tidewater	....	....	....	
Portland	90	Ocean	11,000,000	....	....	
Rumford Falls	90	River	700,000	....	....	
Jefferson City	80	River	....	....	....	
Kansas City	75	Rivers	....	High water only	Centri., elec.	
Marshall	50	Creek	150,000	....	....	
Moberly	80	Small creeks	....	....	....	
Poplar Bluff	40	River	....	....	....	
St. Charles	60	River	500,000	High water only	Centri., elec.	
St. Louis	90	River	140,000,000	....	....	
Montana:						
Billings	90	River	3,400,000a	....	....	
Great Falls	95	River	4,000,000	....	....	
Havre	80	River	300,000	....	....	
Helena	100	Irrigation	....	....	....	
Kalispell	90	Creek	1,250,000	....	....	
Springfield	95	Stream	....	....	....	
Nebraska:						
Beatrice	80	River	1,000,000	....	....	
Fairbury	90	River	....	....	....	
Hastings	90	Sewage ponds	1,000,000	....	....	
Holdrege	50	....	....	....	....	
Lincoln	90	Creek	4,000,000	All	Centrif. elec.	
Omaha	90	River	....	....	....	
York	58	Creek	22,000	....	....	
New Hampshire:						
Concord	95	River	....	....	....	
Laconia	90	Lake	400,000	....	....	
New Jersey:						
Bloomfield	75	Bay-Passaic Val. sewer	3,000,000	....	....	
Camden	80	Rivers & creek	....	....	....	
Harrison	100	Bay-Passaic Val. sewer	4,000,000	....	....	
Hoboken	100	River	....	....	....	
Newark	100	Bay	40,000,000	30,000,000	Cent. steam	
New Brunswick	90	River	6,500,000	....	....	
Nutley	60	Passaic Val. sewer	2,000,000	....	....	
Orange	99	Passaic Val. sewer	4,500,000	....	....	
Phillipsburg	60	River	1,100,000	100,000	Cameron, elec.	
Prospect Park	99	Passaic Val. sewer	200,000	....	....	
Rutherford	90	River and Passaic Val. sewer	275,000	....	....	
Summit	95	Sound	2,000,000	30%	Centrif. elec.	
Union	..	Rivers	....	....	....	
Westfield	95	River	1,500,000	....	....	
West New York	100	River	....	....	....	
New Mexico:						
Albuquerque	98	River	1,250,000	All, 50% twice	Centrif. elec.	
Santa Fe	40	River	....	....	....	
New York:						
Elmira	85	River	2,000,000	....	....	
Endicott	90	River	6,000,000	....	....	
Gloversville	95	Creek	3,100,000	....	....	
Herkimer	90	River	880,000	....	....	
Kenmore	100	River	....	....	....	
Manhattan, N.Y.C.	100	Rivers and bays	800,000,000	40,000,000	Centrif. elec.	
North Tonawanda	90	River	1,700,000	150,000	Centrif. elec.	
Norwich	95	River	....	....	....	
Ogdensburg	80	Rivers	....	....	....	
Oneonta	92	River	1,880,000	....	....	
Port Jervis	95	Rivers	1,100,000	....	....	
Poughkeepsie	98	River	4,000,000	10%	Centrif. elec.	
Rochester	85	Creek, river and lake	37,000,000	150,000	Air lift	
Rome	98	Barge Canal	5,000,000	....	....	
Solvay	100	Lake	500,000	....	....	
Syracuse	95	Lake	25,000,000	All	Centrif. elec.	
Watertown	90	River	4,000,000	....	....	
North Carolina:						
Durham	90	River and creek	4,000,000	All	Centrif. elec.	
Greensboro	75	Creeks	2,000,000	....	....	
Kinston	97	River	800,000	....	....	
Wilmington	99.9	River	....	....	....	

Sewerage Connections, Amounts and Pumping

City	Percentage of residences connected to sewers	Sewage discharged into	Average amount of sewage per day, gas.	Amount of sewage pumped	Kind of pump and power used
North Dakota:					
Bismarck	71	River	400,000	20,000	Centrif. elec.
Fargo	97	River	2,000,000	....	....
Minot	50	River	600,000	All	Centrif. elec.
Ohio:					
Akron	..	River	24,000,000	500,000	Yeomans, elec.
Alliance	95	River	2,850,000	250,000	Centrif. elec.
Bellaire	90	River	....	....	....
Bucyrus	60	River	2,000,000	....	....
Circleville	50	River	....	....	....
Columbus	..	River	26,000,000	All	Centrif. elec.
Conneaut	85	Lake	500,000	....	....
Cuyahoga Falls	75	River	....	....	....
Dayton	98	River	....	10%	Ejectors
East Cleveland	100	Lake	8,000,000	....	....
East Palestine	95	Creek	450,000	....	....
East Youngstown	60	River	90,000	....	....
Elyria	95	River	....	....	....
Lakewood	99.5	Lake	7,000,000	....	....
Lancaster	67	River	....	....	....
Martins Ferry	..	River	2,500,000	....	....
Massillon	70	River	4,000,000	2,000,000	Electricity
Middletown	97	River	3,000,000	....	....
Newark	60	River	....	....	....
New Boston	90	River	....	....	....
Niles	90	River	....	....	....
Struthers	98	River	70,000	....	....
Tiffin	..	River	....	....	....
Troy	50	River	....	....	....
Wooster	97	Creek	....	....	....
Zanesville	70	River	1,500,000	....	....
Oklahoma:					
Ardmore	85	Creeks	1,000,000	....	....
Enid	75	Creek	800,000	All	Centrif. elec.
Ponca City	80	River	....	....	....
Sapulpa	75	Creeks	1,200,000	....	....
Tulsa	95	Rivers	2,000,000	50,000	Ejector, elec.
Oregon:					
Astoria	90	River	....	....	....
Covallis	90	River	....	....	....
Eugene	90	River	....	....	....
La Grande	60	Irrigation ditch	1,250,000	....	....
Oregon City	75	River	....	....	....
Portland	80	Rivers	....	....	....
Salem	90	River	....	....	....
Pennsylvania:					
Allentown	10	Creek	1,000,000	10,000	Centrif. elec.
Berwick	10	River	1,000,000	....	....
Bethlehem	40	River	....	....	....
Bloomsburg	95	River	....	....	....
Butler	95	Creek	2,600,000	8%	Ejectors, elec.
Clairton	80	River	1,200,000	10,000	Electricity
College Hill	80	River	....	....	....
Connellsville	90	River	....	....	....
Duquesne	..	River	....	....	....
Freeland	50	Creek	12,000	....	....
Greenville	96	River	650,000	....	....
Grove City	100	Small creek	750,000	....	....
Hazleton	..	Rivers	3,500,000	....	....
Lewistown	80	River	....	....	....
Munhall	85	River	350,000	....	....
Newcastle	90	River	15,000,000	10,000	Ejector, elec.
Norristown	90	River	1,250,000	....	....
North Braddock	99	River	1,250,000	....	....
Oil City	99	Creek and river	....	....	....
Pitcairn	80	Creek	....	....	....
Rankin	100	River	....	....	....
Reading	50	River	6,900,000	All	Centrif. elec.
Sayre	20	River	250,000	....	....
Sharon	98	River	1,500,000	....	....
Tyrone	60	River	3,000,000	....	....
Uniontown	90	Creek	....	....	....
Warren	90	River	726,000	....	....
Wilkinsburg	100	River	1,500,000	....	....
Rhode Island:					
Westerly	Very small	River	400,000	All	Centrif. elec.
Woonsocket	60	River	....	....	Centrif. steam & elec.
South Carolina:					
Chester	60	Creek	350,000	....	Turbine, elec.
Orangeburg	35	River	....	....	....
Spartanburg	60	Small streams	2,000,000	....	....
Sumter	66	Streams	....	....	....
Union	..	Creek	....	....	....
South Dakota:					
Mitchell	65	River	400,000	....	....
Rapid City	50	River	....	....	....
Sioux Falls	90	River	3,000,000	300,000	Centrif. elec.
Watertown	..	River	400,000	80%	Centrif. elec.
Yankton	80	River slough	400,000	....	....
Tennessee:					
Clarksville	75	River	....	....	....
Dyersburg	85	River	225,000	....	....
Jackson	75	Drainage canal	2,500,000	....	....
Johnson City	75	Creek	....	....	....
Kingsport	90	River	....	....	....
Knoxville	60	River	6,000,000	180,000	Centrif. elec.
Texas:					
Amarillo	85	Dry creek	400,000	20,000	Centrif. elec.
Beaumont	80	Tide water in riv.	5,000,000	....	Wood trash pump
Bronxwood	35	Irrigation	30,000	All	Centrif. elec.
El Paso	83	River	6,000,000	....	Centrif.; gasoline for aux. elec. for main
Fort Worth	80	River	10,000,000	8,000,000	Gould, elec.
Gainesville	80	River	2,500,000	....	....
Galveston	90	Ocean	....	....	....
Houston	80	Ship channel	8,000,000	All	Centrif. elec.
Port Arthur	60	Bayou & canal	....	....	Wood trash, elec.
San Antonio	80	Irrigation	21,000,000	1,500,000	Centrif. elec.
Waco	90	River	2,500,000	....	....
Weatherford	35	.....	75,000	....	....
Utah:					
Ogden	95	River	19,000,000	....	....
Salt Lake City	90	Lake	24,000,000	10,700,000	Centrif. elec.
Vermont:					
Bennington	98	River	....	....	....
Burlington	90	Lake	....	....	....
Rutland	90	Creek	2,000,000	....	....
St. Albans	95	Lake	....	....	....
Virginia:					
Charlottesville	50	River	....	....	....
Clifton Forge	95	River	....	....	....
Staunton	90	Creek	1,000,000	....	....

Sewage Treatment Plants in Michigan

City	Population	Type of Plant	Remarks
Grand Rapids	137,634	.....	Bonds voted for sewers and sewage disposal
Grosse Pointe	2,000	Imhoff tank, contact beds, sand filters	Results satisfactory. High class residential Detroit suburb
Harbor Beach	1,600	Imhoff tank & sand filters	Results satisfactory
Holland	12,183	.....	Bonds voted. Plant to be constructed this year
Mason	1,879	.....	Bonds voted for new plant
Muskegon Heights	9,514	Dortmund tank, separate digestion, contact filters, sand filters	Results satisfactory
Northville	1,738	Imhoff tank, sand filters	Results satisfactory
Plymouth	2,807	.....	Bonds voted. Plant to be built this year
Pontiac	34,273	Imhoff tank, sprinkling filters, secondary sedimentation	Results satisfactory
Reed City	1,803	Settling tank	Results unsatisfactory
Romeo	2,012	Imhoff tank	Secondary treatment needed. Tank satisfactory
Royal Oak	....	Sedimentation, separate digestion, contact filters	A new plant, pop. unknown approx. 15,000. A high class res. suburb of Detroit
Adrian	11,878	.....	Bids received June, 1924, for Imhoff tank, sprinkling filters
Bad Axe	2,140	Imhoff tank, sand filters	Results unsatisfactory. Plant overloaded with creamery waste
Birmingham	5,000	Imhoff tanks	Secondary treatment needed. Tanks satisfactory
Cadillac	9,750	Septic tank, contact filters	Results satisfactory
Caro	2,704	Septic tank, contact filters	Results satisfactory
Coldwater	6,114	Septic tank	Plant overloaded. New plant needed
Dearborn	....	Imhoff tank	Overloaded. A rapidly growing Detroit suburb, pop. about 5,000
Durand	2,672	Septic tank	Secondary treatment needed
East Grand Rapids	....	Dortmund tank, separate digestion, sand filters	Results satisfactory. More filters & digestion tank needed. A rapidly growing high class suburb of Grand Rapids, population about 2,500
Escanaba	13,103	Activated sludge	Unsatisfactory results
Fremont	2,180	Dortmund tank, separate digestion, sprinkling filters, secondary sedimentation, sand filters	Results satisfactory. Industrial wastes from canning factory and tannery reason for such an elaborate plant
Gladstone	4,953	Imhoff tank	Unsatisfactory results
Springwells	....	Imhoff tank	Pop. about 15,000. Ford Rouge industries also connected to this plant. Employ 50,000 men
Sturgis	5,995	Septic tank. Stone filters	Results unsatisfactory. New plant needed
St Johns	3,825	Broad irrigation	Results satisfactory
Zeeland	2,275	Septic tank, sand filters	Results satisfactory. Plant being enlarged
Institutional Plants			
Michigan Home & Training School at Lapeer	2,700	Imhoff tank, sand filters	Results satisfactory
Wayne Co. Home at Eloise	3,000	Imhoff tank, contact bed	Results unsatisfactory Plant overloaded

Sewage Treatment in Rhode Island

Municipal Systems

Place	Type of Purification
Central Falls	Imhoff tank and sprinkling filters
Narragansett Pier	Septic tank for protection of bathing beach
Pawtucket	Sewage from main portion of this city unpurified. Sewage from Lonsdale section piped into Providence for treatment
Providence	Chemical precipitation and chlorination
Warren	Sedimentation and chlorination
Woonsocket	Sand filters
Westerly	Imhoff tanks and slow sand filters

State Institutions

Cranston: House of Correction, State Infirmary, State Hospital	Broad irrigation
Boys' School	Septic tank
Girls' School	Septic tank
Exeter, State School for Feeble Minded	Sand filters
Kingston, State College	Septic tank and chlorination
Wallum Lake, State Sanatorium	Septic tank & sprinkling filters

Sewage Treatment in Tennessee

Information furnished by State Department of Public Health

Brownsville	Septic tanks
Cleveland	Imhoff tanks and sprinkling filters
Covington	Septic tanks
Franklin	Septic tanks
Greeneville	Imhoff tanks and sprinkling filters
Lebanon	Imhoff tanks and sprinkling filters
McKenzie	Settling tanks
Martin	Settling tanks
Milan	Settling tanks
Paris	Septic tanks
Ripley	Septic tanks
Rockwood	Imhoff tank
Sweetwater	Settling tanks
Tullahoma	Settling tanks
Union City	Settling tanks

Sewage Treatment in American Cities--A

City	Gallons treated per day	Tank treatment: Number and kind of tanks	Tank treatment: Average detention period	Tank treatment: Percentage of solids removed: Settleable	Tank treatment: Percentage of solids removed: Total	Tank treatment: Reduction in dissolved oxygen consumed	Secondary treatment: Kind	Secondary treatment: Area, acres	Secondary treatment: Depth, feet	Secondary treatment: Reduction in: Suspended matter	Secondary treatment: Reduction in: Dissolved oxygen consumed	Is chlorine applied to effluent?	Stability of final effluent	Odors at plant?
Arizona:														
Douglas	.....	2 septic	....	....	....	....	None	....	....	....	....	No	....	**No**
California:														
Chico	1,000,000	1 3-cham. Imhoff	2 hrs.	Slight	2	....	....	....	....	....	....	No	....	Yes
Fresno	8,000,000	Septic	5-7 hrs.	60	....	....	Land filtration	400	....	100%	....	No	Stable	Some
Modesto	1,500,000	1 septic	6 hrs.	....	....	....	None	....	....	....	....	No	....	No
Santa Monica	.....	Screening	....	....	....	....	None	....	....	....	....	Yes	....	Some
Santa Rosa	1,250,000	3 special septic	10-12 hrs.	99	45	....	Settling ponds	6	1	100%	95½	Yes	....	**No**
Venice	2,000,000	Dorr screen	....	....	....	....	None	....	....	....	....	No	....	Yes
Visalia	1,000,000	1 Imhoff	111 min.	....	....	....	Irrigation	....	....	....	....	No	....	No
Connecticut:														
Bridgeport	5,000,000	Reinsch-Wurl screen	....	....	....	....	None	....	....	....	....	No	....	No
Middletown	3,000	Imhoff and septic	12 hrs.	50	40	....	....	....	....	....	....	No	....	Slight
Delaware:														
Clayton	75,000	2 septic	....	....	....	....	None	....	....	....	....	....	....	....
Newark	300,000	1 Imhoff	....	....	....	....	Sprink. filters	....	....	....	....	....	....	....
Florida:														
Lakeland	400,000	2 Imhoff	30 min.	....	....	....	....	....	....	....	....	....	....	....
St. Petersburg	3,000,000	Dorr fine screen	....	....	....	....	None	....	....	....	....	....	....	....
Illinois:														
Canton	500,000	2 septic	....	....	....	....	....	....	....	....	....	....	....	....
Kewanee	1,000,000	2 septic	30 min.	Small	Small	....	None	....	....	....	....	No	....	No
Monmouth	600,000	Septic tank—too small	....	....	....	....	....	....	....	....	....	....	....	....
Indiana:														
Princeton	1,000,000	2 Imhoff	130 min.	45	....	....	2 contact beds	0.4	5	65	....	No	....	No
Richmond	.....	2 plts, sediment'n	....	....	....	....	Gravel beds	....	....	....	....	No	....	....
Iowa:														
Ames	600,000	1 Imhoff	2 hrs.	65	....	....	Sprinkling filters	0.35	6	40-50%	....	No	Fair	Sometimes
Centerville	280,000	Septic	7-8 hrs.	....	....	....	Sand beds	1	2c	100%	....	No	....	Yes
Creston	300,000	1 Imhoff 1 septic	3 hrs. 6 hrs.	97	....	....	Sand filter	1.25	2.5	100%	....	No	100%	Slight
Oelwein	670,000	2 40-ft. Imhoff	2 hrs.	....	....	....	Contact beds	0.9	1.5	....	....	No	....In tanks	
Kansas:														
Iola	.....	1 Imhoff (under construction)	....	....	....	....	Sprinkling filter	....	....	....	....	....	....	....
Louisiana:														
Lafayette	350,000d	1 Imhoff	....	....	....	....	Contact beds	0.5	3	....	....	No	....	No
Maine:														
Portland	30,000	Septic	3 hrs.	....	....	....	Contact beds	0.34	5	Effluent clear	....	No	....	Not objectionable
Washburn	150,000	3-compart. septic	....	....	....	....	....	....	....	....	....	....	....	....
Maryland:														
Hagerstown	2,000,000	1 aeration, 1 clarifier e	....	98	....	....	....	....	....	....	....	No	3-10 days	Very little
Massachusetts:														
Andover	254,000	Tank	....	84	....	51	Sand filters	3.65	....	....	....	....	....	....
Attleboro	683 000	None	....	....	....	....	Sand filters	15.5	....	....	....	....	....	....
Brockton	3,200,000	Sediment'n tanks	1.5 hrs.	63	15.9	48	Sprinkl'g filters Sand beds	2 37	9.5 4	33%	50%	No	100%	No
Clinton	1,585,000	Basins	....	82	....	57	Sand filters	26.23	....	....	....	....	....	....
Concord	394,000	None	....	....	....	....	Sand filters	4.28	....	....	....	....	....	....
Easthampton	.....	Tanks	....	50	....	23	Sand filters	2.20	....	....	....	....	....	....
Fitchburg	3,500,000	5 Imhoff	6 hrs.	99	66.6	26.6%	Sprinkling filters	2.08	10	34%	43.4%	No	14-daysf	No
Framingham	1,293,000	None	....	....	....	....	Sand filters	21.12	....	....	....	....	....	....
Franklin	241,000	Tanks	....	77	....	54	Sand filters	3.24	....	....	....	....	....	....
Gardner	1,000,000	None Tanks	....	....	....	....	Sand filters	12.50	....	....	....	....	....	....
Hopedale	167,000	Tanks	....	81 44	....	52 33	Sand filters	3.79	....	....	....	....	....	....
Hudson	552,000	Tanks	....	67	....	48	Sand filters	9.00	....	....	....	....	....	....

Leicester	....	None	....	....	....	....	Sand filters	....	....	....	....	....	....	....
Marion	97,000	None	....	....	....	....	Sand filters	0.75	....	....	....	....	....	....
Marlborough	1,064,000	Tanks	....	63	....	28	Sand filters	20.90	....	....	....	....	....	....
Milford	461,000	Tanks	....	....	....	41	Sand filters	9.30	....	....	....	....	....	....
Natick	744,000	None	....	....	....	....	Sand filters	12.60	....	....	....	....	....	....
North Attleborough	628,000	Tanks	....	45	....	32	Sand filters	7.00	....	....	....	....	....	....
Northbridge	787,000	Tanks	....	63	....	53	Sand filters	12.00	....	....	....	....	....	....
Norwood	897,000	Tank	....	28	....	26	Sand filters	10.54	....	....	....	....	....	....
Pittsfield	3,078,000	None	....	....	....	....	Sand filters	41.15	....	....	....	....	....	....
Southbridge	1,031,000	Tanks	....	32	....	18	Sand filters	8.50	....	....	....	....	....	....
Spencer	....	None	....	....	....	....	Sand filters	9.30	....	....	....	....	....	....
Stockbridge	....	None	....	....	....	....	Sand filters and irrigation	....	....	....	....	....	....	....
Westborough	440,000	None	....	....	....	....	Sand filters	5.80	....	....	....	....	....	....
Worcester	22,110,000l	14 chem. precipition, 2 settling	4 hrs.	70	25	71	Sand filters	66.80	4-6	100%	....	No 1-2 days	filters 14 days	No(g)
Michigan:														
Coldwater	....	Septic	....	....	....	....	None	....	....	....	....	No	....	Sometimes
Hastings	4,000	1 Imhoff	2 hrs.	90	....	....	....	....	....	....	....	No	....	Very little
Minnesota:														
Rochester h	2,500,000	Activated sludge	7 hrs.	....	....	....	....	....	....	....	....	No	....	....
Virginia	900,000	2 Imhoff	2 hrs.	....	....	....	Percolating filter	0.53	8	....	....	No	....	Not much
Missouri:														
Columbia	....	1 Imhoff	....	....	....	....	....	....	....	....	....	....	....	....
Fulton	....	2 septic	48 hrs.	....	....	....	None	....	....	....	....	....	....	....
Independence	....	3 Imhoff	....	....	....	....	Sprinkling filters	....	....	....	....	No	....	Some
Kansas City	300,000	2 septic	6 hrs.	....	....	....	6 contact beds	0.14	4	....	....	No	....	Not much
Springfield	3,000,000	2 Imhoff, 1 septic	....	....	....	....	Sprinkling filters, settling basin	1.26	6	....	....	No	....	Slight at times
Nebraska:														
Hastings	1,000,000	Sewage ponds	....	....	....	....	....	22.0	2	....	....	....	....	Slight
Holdrege	....	1 Imhoff	....	60	....	....	None	....	....	....	....	No	....	Some
Lincoln j	4,000,000	Alvord separate sludge digestion	....	75.3	47.2	....	Sprinkling filters	2.8	6	21%	....	Experimentals	....	Yes
New Jersey:														
Phillipsburg	1,100,000	Direct oxidation, with sedimentat'n	1 hr.	....	....	....	....	....	....	....	....	No	....	No
Westfield	1,500,000	1 circular Imhoff	3 hrs.	....	....	....	Sand filters	6	4	....	....	No	....	At times
New Mexico:														
Albuquerque	1,250,000	Sedimentation	1 hr.	90	80	....	Contact beds	0.11	6	95%	....	Yes	5	Very little
New York:														
Gloversville	2,900,000	Dortmund—2 primary, 2 secondary	3.5 hrs.	83	58	30k	Sprinkling filters	3.07	5	60%	68%k	No	100%	From sludge beds
Kenmore	1,000,000	Imhoff	32 hrs.	....	....	....	Contact beds l	0.06	4	....	....	Yes	....	No
New York (Manhattan	7,000,000	Fine screen	....	....	....	....	....	....	....	....	....	Yes	....	No
	40,000,000	Fine screen												
Rochester	35,000,000	13 Ihmoff (4 plts)	50 min-6 hrs	40-95	....	20-90	Sprinkling filter for 1,500,000 gal.	1	6	50%	75%	No	21 days	No
Syracuse	25,000,000	4 sedimentation with continuous sludge removal	1 hr.	....	60	....	None	....	....	....	....	No	....	None
North Carolina:														
Durham	4,000,000	1 Imhoff, 1 septic	6 hr. Im. 8 hr. sep.	85	....	....	Sand filter beds	1.35	3.5	Effluent clear	....	1 plant	....	Some
Greensboro	....	4 septic	12 hrs.	90	60	....	None	....	....	....	....	No	....	Not much
North Dakota:														
Minot	1,000,000	2 Imhoff	10 hrs.	....	....	....	Sprinkling filter	0.8	8	....	....	No	....	Some
Ohio:														
Akron	7,500,000	12 Imhoff	2 hrs.	90	....	....	Sprinkling filter	4	5	....	....	No	10 days	None objection.
Alliance	2,500,000	2 Imhoff, 2 sedimentation	4.2 hrs.	65	....	....	Contact beds (cinders and sand)	3	5	....	....	No	75%	Yes
Columbus	26,000,000m	22 Imhoff	4.6 hrs.	96	60.6	38.5	Sprinkling filters, sec. sedimentat'n	10	5.5	23	85	No	39%	Some
Conneaut	30,000n	Imhoff	4 hrs.	95	....	....	Filter beds	0.15	1	....	....	No	97%	No
East Palestine	....	2 Imhoff	1 hr.	....	....	....	None	....	....	....	....	No	....	Some
Lakewood	7,000,000	4 Imhoff	3.5 hrs.	99.3	61	....	None	....	....	....	....	No	....	No

Sewage Treatment—A—(Continued)

City	Gallons treated per day	Tank treatment: Number and kind of tanks	Tank treatment: Average detention period	Tank treatment: Percentage of solids removed: Settleable	Tank treatment: Percentage of solids removed: Total	Tank treatment: Reduction in dissolved oxygen consumed	Secondary treatment: Kind	Secondary treatment: Area, acres	Secondary treatment: Depth, feet	Secondary treatment: Reduction in: Suspended matter	Secondary treatment: Reduction in: Dissolved oxygen consumed	Is chlorine applied to effluent?	Stability of final effluent	Odors at plant?
Oklahoma:														
Ardmore	1,000,000	2 Imhoff	4 hrs.	....	....	....	4 contact beds	0.55	4.5	....	....	No	....	Slight
Enid	800,000	1 Imhoff	....	....	....	....	Sprinkling filters	1.11	6	....	....	No	....	No
Tulsa	400,000	2 Imhoff	2 hrs.	....	....	....	2 sprinkl'g filters	0.78	6	....	....	Yes	....	....
Oregon:														
La Grande	1,250,000	Settling	2 hrs.	50	20	....	None	....	....	....	....	No	....	Very perceptible
Pennsylvania:														
Allentown	1,000,000	Direct oxidation	....	....	....	....	....	....	....	....	50%	No	37%	No
Bethlehem	500,000	2 screens	....	....	....	....	....	....	....	....	....	....	....	....
Butler h	.....	Plain sediment'n, separate sludge	2 hrs.	....	....	....	None	....	....	....	....	....	....	....
Clairton p	200,000	Septic	....	....	....	....	Contact beds	0.5	5	....	....	....	....	Slight at times
College Hill q	.....	2 septic	....	....	....	....	....	....	....	....	....	....	....	....
Greenville	650,000	2 Imhoff	....	....	....	....	....	....	....	....	....	Yes	....	....
Grove City	750,000	Separate digest'n	2 hrs.	85	....	....	None	....	....	....	....	Yes	....	No
Reading	6,000,000	Sedimentation	6 hrs.	28	....	2 p.p.m.	Sprinkling filter	4	5	42%	1.7 p.p.m.	No	82	Very Slight
Rhode Island:														
Westerly	400,000	Imhoff	2 to 3 hrs.	55	....	....	Filter beds (under construction)	....	....	....	....	No	....	No
Woonsocket	1,000,000	.....	....	....	....	....	Intermittent filtration	12	....	97	....	No	....	Slight greasy
South Carolina:														
Sumter	.....	2 septic tanks	....	....	....	....	....	....	....	....	....	No	....	No
Texas:														
Amarillo	400,000	Imhoff	8 hrs.	75	....	....	None	....	....	....	....	No	....	Some
Brownwood	30,000	1 Imhoff	20 hrs.	....	....	....	Sprinkling filters (under constn)	0.25	4	....	....	Will be	....	Not object.
El Paso	6,000,000	Settling & skim'g	4 to 6 hrs.	78	....	29.5	None	....	....	....	....	No	....	Occas r
Fort Worth	5,000,730	4 Imhoff	1.8 hrs.	93.4	17.1	50	Sprinkling filters	3.18	8.2	12%	90	No	99%	t
Gainesville	2,500,000	Activated sludge	....	....	....	....	....	....	....	....	....	No	....	Some
Houston	8,000,000	Activated sludge	5 hrs.	....	90	93	None	....	....	....	....	No	92	No
Weatherford	.....	1 septic	....	....	....	....	Filter beds	1.38	12	....	....	No	....	Yes
Virginia:														
Abingdon	200,000	2 3-unit septic plants	....	....	....	....	....	....	....	....	....	Yes	....	....
Chase City	100,000	2 plants, 3-unit septic; 1 plant, 2 septic	....	....	....	....	....	....	....	....	....	....	....	....
Colonial Beach	100,000	1 2-unit septic	....	....	....	....	....	....	....	....	....	....	....	....
Front Royal	125,000	1 2-unit septic	....	....	....	....	....	....	....	....	....	....	....	....
Harrisonburg	500,000	Imhoff	....	....	....	....	6 sand filters (not used)	1.67	....	....	....	....	....	....
Manassas	75,000	Imhoff	....	....	....	....	2 sprinkl'g filters	0.05	5	....	....	Soon	....	....
South Hill	75,000	2 plants, 1 septic; 1 plant, 2 septic	....	....	....	....	....	....	....	....	....	....	....	....
Winchester	350,000	Imhoff	....	....	....	....	Sprinkling filter, final sedimentat'n	....	....	....	....	....	....	....
Washington:														
Seattle	200,000	3 Imhoff	2 hrs.	85	42.5	....	Contact beds	....	....	15%	....	Yes	90%	Slight
Walla Walla h	12,000,000	Sedimentation	3 hrs.	....	....	....	Sludge digestion tank	....	....	....	....	Yes	....	....
Wisconsin:														
Antigo	1,000,000	3 septic	....	....	....	....	Contact beds	2.29	3	....	....	No	....	Yes
Fond du Lac	1,500,000	6 Imhoff	1 to 1.5 hrs.	....	Very small	None	None	....	....	....	....	No	....	Yes
Wyoming:														
Sheridan	1,500,000	2 septic	....	10	....	....	Gravel beds	0.92	1	Almost entirely	....	No	Very low	Yes

a—Includes repairs. b—Power, $1,361 labor, $1,150; repairs, $97; misc., $46. c—Originally 3 ft. d.—Designed for 250,000 gallons. e—Plant under construction. f—Not kept any longer. g—Chemical precipitation 1 to 2 days; filters, 14 days. Occasionally odors from sludge. h—Planning one. i—3,560,000 gals. by sand filters. j—Sanitary District No. 1 of Lancaster Co. k—Reduction in total oxygen consumed. l—Sprinkling filters proposed. m—Designed for 20,000,000. n—From a small section too low to drain into sewers. p—By private land company. q—Plant used jointly with Beaver Falls. r—when more than 4 hr. displacement period if continued over 2 hrs. s—Digested 6 to 12 months and pumped onto low lands. t—Odors not noticeable at first, but have been since treating packing house waste.

Sewage Treatment—B

City	Disposal made of sludge	Cost last year of Operating the plant	Cost last year of Repairs to plant
Arizona:			
Douglas	Spread on ground	None	None
California:			
Chico	Sludge beds, ½ acre	None	None
Fresno	None	$19,000a	....
Modesto	Spread on farm	250	$1,500
Santa Monica	Carted away	10,000	None
Santa Rosa	For fertilizer	1,500	....
Venice	Buried	....	....
Visalia	Dried for fertiliz'r	500	....
Connecticut:			
Bridgeport	Buried	25,000	....
Middletown	City dump	700	$3,500
Delaware:			
Clayton	.....	....	....
Newark	.....	....	....
Florida:			
Lakeland	Open ditching	1,000	....
St. Petersburg	.....	....	....
Illinois:			
Canton	.....	....	....
Kewanee	Land fertilizer	Small	None
Monmouth	.....	....	....
Indiana:			
Princeton	Spread on farms	$1,100	None
Richmond	Filling	....	....
Iowa:			
Ames	Fill around plant	2,654b	....
Centerville	Fill adjacent land	500	....
Creston	Sanitary fill	....	....
Oelwein	None yet	....	....
Kansas:			
Iola	2 sludge beds	....	....
Louisiana:			
Lafayette	Widen level around plant	360	None
Maine:			
Portland	Fertilizer field	50	50
Washburn	....	....	....
Maryland			
Hagerstown	City farm	....	....
Massachusetts:			
Andover	....	....	....
Attleboro	....	....	....
Brockton	Dried on sand & buried	18,794a	....
Clinton	....	....	....
Concord	....	....	....
Easthampton	....	....	....
Fitchburg	Wasted on dump	13,884	....
Framingham	....	....	....
Franklin	....	....	....
Gardner	....	....	....
Hopedale	....	....	....
Hudson	....	....	....
Leicester	....	....	....
Marion	....	....	....
Marlborough	....	....	....
Milford	....	....	....
Natick	....	....	....
N. Attleboro	....	....	....
Northbridge	....	....	....
Norwood	....	....	....
Pittsfield	....	....	....
Southbridge	.....	....	....
Spencer	.....	....	....
Stockbridge	.....	....	....
Westborough	.....	....	....
Worcester	Lagoons	65,694a	....
Michigan:			
Coldwater	On field	....	....
Hastings	.....	140	None
Minnesota:			
Rochester (h)	Ponding	....	....
Virginia	Land adjoin. plant	....	....
Missouri:	.....		
Columbia	.....	....	....
Fulton	.....	....	....
Independence	None yet	5,000	500
Kansas City	.....	....	2,000
Springfield	Fertilizing	4,500	1,250
Nebraska:			
Hastings	Piled up	1,500a	....
Holdrege	Farmers use it	New plant	....
Lincoln (j)	Filling	12,500	1,500
New Jersey:			
Phillipsburg	Dump	....	....
Westfield	Used by farmers	3,000	200
New Mexico:			
Albuquerque	As fertilizer	4,000	None
New York:			
Gloversville	Fill low land	12,500	300
Kenmore	As fertilizer	....	None
New York (Man.)	.....	....	....
Rochester	Sold to farmers	71,000	3,000
Syracuse	Sterilized & bury	....	....
North Carolina			
Durham	Dried & used on farm	1,650	30
Greensboro	Cast on land	....	....
North Dakota:			
Minot	Used as fertilizer	8,500	....
Ohio:			
Akron	Dump on low grd	14,122	500
Alliance	Farmers	5,709	187
Columbus	Sludge beds and lagoon	51,702	1,689
Conneaut	None	.....	....
East Palestine	Used as fertilizer	1,200	300
Lakewood	Dried on beds & dumped	4,836	625
Oklahoma:			
Ardmore	Dried	2,000	600
Enid	Dried & used as fertilizer	3,000	300
Tulsa	Fill	New plant	....
Oregon:			
La Grande	None	....	None
Pennsylvania:			
Allentown	Lagoon	15,000	1,000
Bethlehem	.....	....	....
Butler (h)	.....	....	....
Clairton (p)	Buried	....	....
College Hill (q)	.....	....	....
Greenville	On low land	805	....
Grove City	Glass cov. sludge beds; fill	....	....
Reading	Buried	....	....
Rhode Island:			
Westerly	.....	1,200	None
Woonsocket	Dumped	....	....
South Carolina:			
Sumter	In trenches	300	None
Texas:			
Amarillo	Dried	1,000	....
Brownwood	Fill low land	1,800	150
El Paso	Fill low land (s)	....	....
Fort Worth	Drying & lagoon.	29,829	1,785
Gainesville	Sludge beds and burned	1,200	....
Houston	Lagoons	42,000	6,000
Weatherford	.....	1,200	1,000
Virginia:			
Abingdon	Sludge beds	....	....
Chase City	.....	....	....
Colonial Beach	Into river	....	....
Front Royal	.....	....	....
Harrisonburg	Sludge beds	....	....
Manassas	Sludge beds	....	....
South Hill	Sludge beds	....	....
Winchester	Sludge beds	....	....
Washington:			
Seattle	.....	....	....
Walla Walla (h)	.....	....	....
Wisconsin:			
Antigo	On farms	1,500	None
Fond du Lac	For fill	6,612	....
Wyoming:			
Sheridan	Dried	500	None

(For footnotes, see page 262)

Sewage Treatment Plants in Oklahoma

Information Furnished by State Department of Health

City	Population	Type of Treatment
Ada	8,000	Imhoff tank, contact beds.
Afton	1,500	Septic tank.
Altus	6,000	Septic tank.
Ardmore	10,000	Septic tank sprinkling filters.
Beaver	1,200	Septic tank.
Beggs	2,300	Septic tank, sprinkling filters.
Bristow	3,500	Imhoff tank, sprinkling filter.
Britton	1,000	Septic tank.
Broken Arrow	2,000	Two septic tanks.
Broken Bow	2,000	Imhoff tank, sprinkling filter.
Burbank		Septic tank.
Cardin	3,000	Imhoff tank, chlorinator.
Chandler	2,500	Septic tank.
Checotah	2,500	Two septic tanks.
Claremore	4,000	Imhoff tank, contact beds.
Coalgate	3,500	Electrolytic (never used), septic tank, chloride of lime.
Collinsville	5,000	Septic tank.
Cordell	2,500	Imhoff tank.
Comanche	2,500	Septic tank and sand filter.
Commerce	4,500	Imhoff tank, contact beds.
Davis	2,000	Imhoff tank.
Depew	1,500	Imhoff tank.
Dewey	2,700	Electrolytic (not working).
Dilworth	600	Septic tank.
Devol	1,300	Imhoff tank.
Drumright	10,000	Imhoff tank, contact beds.

City	Population	Type of Treatment
Duncan	7,000	Imhoff tank, sprinkling filter.
Durant	8,000	Imhoff tank and electrolytic plan.
Edmond	3,000	Septic tank.
Elk City	3,500	Septic tank, contact beds.
El Reno	10,000	Imhoff tank.
Enid	18,000	Imhoff tank, sprinkling filter.
Erick	1,000	Septic tank, contact beds.
Fairfax	1,300	Septic tank, sprinkling filter.
Fairview	1,800	Septic tank, contact beds.
Fort Reno		Septic tank.
Frederick	3,800	Imhoff tank, chlorination.
Garber	1,500	Septic tank, chlorination.
Geary	2,300	Imhoff tank, sprinkling filter.
Grandfield	1,700	Septic tank.
Hartshorne	3,500	Septic tank.
Heavner	780	Imhoff tank, filters.
Hennessey	1,900	Septic tank, sand filter.
Henryetta	6,000	(Electrolytic abandoned.) Imhoff and sprinkling filters.
Hobart	3,500	Septic tank, Imhoff tank, chlorination.
Holdenville	3,000	Septic tank, sprinkling filters.
Hugo	6,500	Septic tank.
Idabel	3,200	Imhoff tank, contact beds.
Jennings	1,000	Septic tank.
Kaw City	1,800	Imhoff tank.
Kiefer	1,800	Imhoff tank.
Lawton	9,000	Septic tank.
McAlester	20,000	Imhoff tank.
Madill	4,000	Septic tank.
Marlow	2,800	Imhoff tank, sprinkling filter, chlorination.
Miami	8,000	Imhoff tank, sprinkling filter.
Morris	2,000	Septic tank, sprinkling filter.
Mounds	1,500	Imhoff tank.
Newkirk	2,500	Septic tank.
Nowata	5,000	Septic tank.
Oilton	2,750	Septic tank.
Okemah	2,200	Imhoff tank, sprinkling filter.
Oklahoma City	100,000	Septic tank.
Okmulgee	17,000	Imhoff tank, sprinkling filter.
Pawhuska	7,000	Septic tank and Imhoff tank, sprinkling filter.
Perry	3,500	Imhoff tank.
Pershing	1,500	Imhoff tank
Picher	4,000	Imhoff tank, chlorination.
Pryor	2,000	Septic tank.
Quapaw	1,000	Imhoff tank.
Ralston	1,000	Imhoff tank.
Rush Springs	1,200	Septic tank, contact beds.
Sallisaw	2,500	Imhoff tank.
Shattuck	1,800	Septic tank.
Skiatook	1,700	Septic tank.
Snyder	1,400	Septic tank, chloride of lime.
Stilwell	1,250	Septic tank.
Tahlequah	2,500	Septic tank.
Tecumseh	2,000	Septic tank.
Temple	1,200	Septic tank, contact beds.
Vinita	5,000	Septic tank.
Wagoner	4,000	Septic tank.
Watonga	1,800	Septic tank.
Waynoka	1,500	Septic tank.
Weatherford	2,500	Septic tank, filters.
Wynnewood	2,200	Imhoff tank, sprinkling filter.
Wilburton	2,000	Imhoff tank, septic tank, sprinkling filter, chlorination.
Wynona	2,000	Imhoff tank, contact beds.
Yale	3,000	Activated sludge.
Yukon	1,250	Septic tank.

In addition, at the time of this report plans had been approved for the following: Bristol—Imhoff tank, chlorinator and sludge bed; also sprinkling filter. Broken Bow—Imhoff tank, sprinkling filter and sludge bed. Burbank—Septic tank. Comanche—Septic tank and sand filter. Duncan—Imhoff tanks, sludge beds, secondary sedimentation tanks, and sprinkling filters. Depew—Imhoff tank and sludge bed. Fairfax—Imhoff tank, sludge bed and sprinkling filter. Henryetta—Imhoff tank, sludge bed and sprinkling filter. Hobart—Imhoff tank, sludge bed and chlorinator. Kaw City—Imhoff tank. Marlow—Imhoff tank, sprinkling filter, sludge bed and chlorinator. McAlester—Imhoff tanks and sludge beds. Perry—Imhoff tank and sludge bed. Pawhuska—Imhoff tank, sprinkling filter and sludge bed. Ralston—Imhoff tank. Shattuck—Septic tank and sludge bed. Stilwell—Septic tank and sludge bed. Wilburton—Imhoff tanks, sprinkling filters, sludge beds and chlorinators. Waynoka—Septic tank and sludge bed.

Sewage Disposal Plants in Maryland

Corrected to January, 1925. Information furnished by State Department of Health

MUNICIPAL

Place	Estimated Population 1925	Method of Treatment
Aberdeen	1,323	Settling tanks, separate sludge digestion and trickling filter
Aberdeen Proving Grounds	U. S. Government Reservation	Settling tanks
Baltimore City	791,629	Hydrolytic tanks, separate sludge digestion, revolving screens, trickling filters, final settling tanks
Back River	600,000	
Mt. Washington	3,000	Settling tank
Roland Park	2,000	Sand filters
Ten Hills	1,000	Settling tank & sand filters
Belmar	600	Settling tank & sand filters
Braddock Heights	200	Settling tank & subsurface irrigation
Camp Holabird	U. S. Government Reservation	Septic tank & chlorination
Camp Meade	U. S. Government Reservation	Settling tanks
Catonsville Park	600	Settling tank and chlorination
Chesapeake Beach	Summer Resort	Bar screen & chlorination
Chevy Chase	Summer Resort	Settling tank & contact beds. Broad irrigation
Decatur Heights	Summer Resort	Settling tank
Dundalk	5,000	Settling tank
Easton	3,645	North plant—settling tanks. South plant—settling tank & sand filter
Gwynn Oak Park	Summer Resort	Settling tank & sand filters
*Hagerstown	34,610	Bar screen, Dorrco screen and Dorrco clarifier
Laurel	2,139	Settling tanks
Ridgely	733	Settling tank
Rockville	1,124	Settling tank & sand filters
Savage	1,050	Settling tank and chlorination
Stoneleigh	500	Settling tank
Takoma Park	4,259**	Sand filters
Tolchester Beach	Summer Resort	Settling tank with sand filters
Towson	5,000	Primary settl'g tank, trickling filter and secondary set. tank
Sparrows Point	5,000	Settling tank

*Grit chamber and activated sludge plant under construction. **In Washington Surban Sanitary District.

INSTITUTIONS

Institution	Estimated Population 1925	Method of Treatment
Baltimore Co. Almshouse (Texas)	100	Settling tank & sand filters
Buckingham Industrial School (Buckeystown)	100	Settling tank and subsurface irrigation
Crownsville State Hospital (Crownsville)	600	Primary settling tank, trickling filter, secondary settling tank and sand filters
Eudowood Sanatorium (Towson)	...	Septic tank and subsurface irrigation
Hoods College (Frederick)	600	Contact beds
Jewish Home for Consumptives (Reisterstown)	80	Bar screen, primary settling tank, trickling filter, secondary tank & chlorination
Maryland House of Correction (Bridewell)	700	Settling tank, trickling filter, secondary settling tank & chlorination
Maryland Training School for Boys (Loch Raven)	200	Settling tank
Maryland Tuberculosis Sanatorium (Sanatorium)	600	Settling tank, trickling filter, secondary settling tank and sand filters
Maryland Tuberculosis Sanatorium (Colored Branch)—Hentryton	150	Settling tank & chlorination
McCready Memorial Hospital (Crisfield)	125	Settling tank
Montrose School for Girls (Woodensburg)	125	Settling tank
Notre Dame Academy, Baltimore City	350	Septic tank and subsurface irrigation
I. O. O. F. Home (at Frederick)	175	Settling tank
Rosewood Training School, Owings Mills	835	Settling tank and trickling filter
Springfield State Hospital, Sykesville	1800	Settling tank, trickling filter and final settling tank
Spring Grove Hospital, Catonsville	1,200	Setting tank and broad irrigation
University of Maryland, College Pk.	500	Settling tanks
*Maryland Tuberculosis Sanatorium (Mt. Wilson)	...	Screen chamber, settling tank and chlorination

*Under construction.

St. Louis Water Works Notes

Unusual promptness in publishing. Universal metering. Economy in scrapping boilers. Uncovered reservoirs. Mud balls in filters.

A report of 225 pages has been published by Edward E. Wall, Water Commissioner of St. Louis, covering the fiscal year ending April 13th, 1925. Mr. Wall's report is dated April 25th; and a bound copy of the report was in our hands two months from that date. This is excellent and unusual promptness in getting out any extensive report, and especially one containing the reports of thirteen heads of divisions and other assistants, the delay of any one of whom would have held up the report; and in which scores of tables, diagrams and photographs add to the possibilities of delay. This would seem to demonstrate that the delays of months and sometimes years in getting out annual reports of which some municipal departments are habitually guilty are entirely unnecessary and should not be tolerated.

Certain paragraphs of this report impressed us as being of general interest and are quoted below.

WATER METERS

"The City of St. Louis should not be guilty in this twentieth century of the folly of continuing to supply water at flat rates, when the experience of other cities and the expert opinions of engineers and water works operators all point to the abandonment of such a policy. The adoption of universal metering just after the new works are put in service will result in a gradual reduction in the daily per capita consumption of water, the postponement of additions to the new plant and a substantial extension of the period that the water works as a whole will be capable of supplying the city. The installation of meters should be spread over a period of at least five years so that the expense could be met from water works revenue, and so that ample time might be allowed for satisfactory adjustment in rates as the change was made from flat to meter rates. In the end there should be practically the same rate per hundred cubic feet for all consumers, the only differences being a slight increase in the service charge to small consumers to cover the extra cost of reading meters, billing, etc., for a large number of consumers, who use no more water than one factory supplied through one meter. Such a scheme would greatly reduce the trouble and labor of assessing and collecting water rates, would be eminently fair and just to all water users, and infinitely preferable to the present system of preferred consumers and inquitable flat rates."

WHEN PURCHASE OF NEW BOILERS IS ECONOMICAL

"The boiler plant at Bissell's Point, built in 1908 and changed in some details at various times during the seven or eight years thereafter, is now in need of extensive repairs. By remodeling this plant it would be serviceable for not more than four years longer, so that the economical thing to do is to install new boilers with modern settings, superheaters, water softener, soot-blowers, etc., which would give service for twenty years. The estimated annual saving in cost of operation of the new boilers over the old is $13,341.00, which represents a return of almost nine per cent on an investment of $150,000.00, which is estimated to more than cover the cost of the new boilers and equipment. An ordinance authorizing the work and appropriating the money to pay for it has been passed and the plant will be reconstructed this year."

TROUBLE FROM UNCOVERED RESERVOIRS

"At this time it seems proper to again mention the fact that the necessity for covering the clear water storage reservoirs is more important than ever before as it is impossible to maintain wholesome water as long as the reservoirs containing pure sparkling water are leftt uncovered, exposing an area of 28.93 acres of water surface to contamination either by dust and refuse from the streets as at Baden and Compton Hill reservoirs or by refuse blown from a public dump and passing cattle cars as at Bissell's point reservoirs.

"The basins at Compton Hill were treated four times with copper sulphate; twice in May, once in June and once in July. The amount added varied from 60 to 160 pounds per basin or from 0.2 to 0.53 part per million.

"At the beginning of April very few organisms were present in the water in these basins, but by the end of the month there were over 800 per cubic centimeter present. On May 7 and 8, the water was treated at the rate of 0.27 part per million without any appreciable reduction in number resulting. On May 16 and 17, the water was again treated, this time with 0.2 part per million of copper sulphate. No decrease followed this treatment and by the end of May the number had increased to 900 per cubic centimeter. On June 2 and 3, the water was again treated with copper sulphate, this time using 0.53 part per million. A reduction to 40 per cubic centimeter followed this treatment but by July 7 the count was again 900 and on July 8 and 9 another treatment of 0.53 part per million was given the water. Excellent results followed this treatment but by July 21 the count had risen to 900 again so the basins were taken out of service and cleaned and no further treatments with copper sulphate were resorted to although the count had increased to 375 by September 17. After that date the count steadily decreased until in January no organisms were present in the Compton Hill water."

COUNTING MUD BALLS IN FILTERS

"The rate of washing filters has not been changed throughout the year, and is at the rate of 15 gallons per square foot per minute. By washing at this rate there has been no noticeable change in the size and number of mud-balls. Once each month a ¼-inch screen is pulled through one section of each half of filter while washing, then these mud-balls are counted and their size noted, thereby keeping a constant check on conditions of sand bed."

California Highway Finances

After a careful analysis of the accounts of the Highway Department of California and a reasonable estimation of the funds to be anticipated from gasoline and motor license fees, W. F. Mixon, secretary of the California Highway Commission, states that there will be available for highway work at all times during the two-year period from July 1st, 1925 to June 30th, 1927, $34,074,000, or $24,849,000 in addition to sums allocated to work already authorized.

A law recently passed requires maintenance of all traversable roads now in the system on which no work has been done, which total approximately 1240 miles. With funds drawn from the two-cent gas tax these roads will be improved and gradually brought to a satisfactory condition and in the meantime will be maintained in such condition as to afford easy and comfortable accommodations to the traveling public. Meantime, since it is not required that hard surfaces be built at once on all this mileage, more funds will be available to be concentrated on the most important parts of the main routes.

The Commission expects to carry on a progressive plan of reconstruction and maintenance, having available about eleven million dollars a year for this purpose, about $7,500,000 of which will come from the two-cent gas tax and $3,500,000 from the motor vehicle license fees. For new construction, the Commission has in cash on hand approximately $2,300,000; $4,200,000 is yet to be collected from previous Federal Aid allotments, while additional Federal Aid amounting to $4,900,000 now becomes available, giving a total of $11,400,000 available for new construction, of which $3,200,000 will be required to meet construction contracts already in force.

The gas tax receipts which it is estimated will be available during this two-year period comprises $4,000,000 due November, 1925; $7,800,000 to be called in 1926, and $3,674,000 in the first half of 1927; giving a total of $15,474,000. There was cash on hand on July 1st, 1925, amounting to about $3,200,000, but good business dictates that an equal balance should be carried over on July 1st, 1927. Computations of the amount that will be available from motor vehicle license fees indicate that this will be about $3,450,000 for 1925, and $3,750,000 for 1926. These sums will be used for reconstruction and maintenance.

Passaic Valley Sludge Disposal

The sewage brought from the municipalities in the Passaic Valley by the Passaic Valley sewer is treated in sedimentation tanks on the Newark Meadows before the effluent is discharged into New York harbor. The sludge so collected is pumped from the sludge tank into scows and dumped at sea. On June 25th, the Passaic Valley Sewage Commission awarded the contract for carrying this sludge to sea to Joseph O'Boyle of Brooklyn, New York, at his bid of 37c. a ton. Other bids were 45c. and 47c. respectively. It is estimated that $190,000 tons will have to be taken to sea during the 12-month period beginning July 15th.

Asphalt Sales in 1924

The Geological Survey of the Department of the Interior reports that the amount of asphalt and related bitumens produced in the United States in 1924 exceeded that of the previous year in both quantity and value. The sales of native asphalt and related bitumens were 570,000 short tons, valued at $3,988,000. The sales of asphalt manufactured from domestic petroleum were 1,158,000 short tons, valued at $14,306,000; while that manufactured from foreign petroleum totaled 1,920,000 tons, valued at $21,711,000.

Pennsylvania Sewage Treatment Plants

The Department of Health of Pennsylvania, through the courtesy of H. E. Moses, assistant chief engineer, has furnished us with a list of 181 plants (some of which are in duplicate or triplicate) which is believed to be all that there are in the state. About 60 of these are municipal plants and the other 121 are operated by institutions, manufacturing plants and so forth. Of the total number of plants 106 are provided with screens and 5 with grit chambers. All but two pass the sewage through some kind of tank, 101 of these being septic tanks, 73 Imhoff tanks, 3 settling tanks, one Alvord tank, and one direct oxidation or electrolytic plant.

The secondary treatment is distributed among a greater variety of filters and other contrivances. Seventy-three use trickling filters, 29 contact beds, 25 sand filters, 4 cinder filters, 5 sub-surface irrigation, 9 irrigation fields, and one absorption well. Sludge beds are found at 128 plants, settling basins at 71, lagoons at 2, and separate sludge digestion at one.

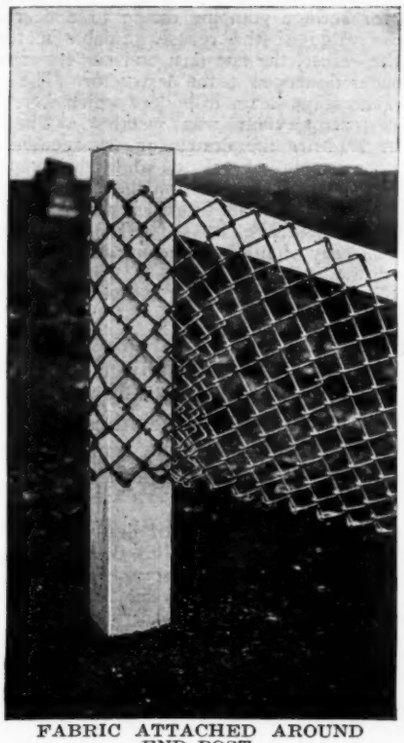
The effluents are treated with chlorinated lime at 57 plants and with chlorine gas at 27.

Contractors License Law

The first legislation in this country providing for the licensing of general contractors was enacted in May by the State of North Carolina. A similar law was proposed but rejected by the Pennsylvania legislature some time previous.

The North Carolina law applies to persons, firms or corporations undertaking the construction of bridges, highways, buildings, or other structures with a value of $10,000 or more. A board of five members is to be appointed by the governor for administering the law, and this board may require either written or oral examinations to determine the fitness of an applicant for a license. Licenses will run for one year and the cost will be twenty dollars for the first year and ten dollars for each annual renewal. Violation of the law may be punished by a fine of not less than $500 or imprisonment for three months, or both. The license board may adopt such rules, by-laws and regulations as it may think best.

This movement for licensing contractors follows closely the one for licensing engineers and presumably the reasons are quite similar in the two cases. Probably the argument having the most weight with the majority of contractors is that the licensing board will refuse licenses to the contractors who are in-



FABRIC ATTACHED AROUND END POST.

competent, inexperienced and financially unable to perform the work required, and who now cause trouble and loss to the competent contractors by bidding unnecessarily low and by doing poor work and thus bringing the entire contracting profession into ill repute.

The operation of the North Carolina law will be watched with interest and the outcome there will probably have considerable bearing on the action taken in the matter by other states.

Sewage Filter Flies

In his annual report as chief engineer of the Board of Sanitary Engineering of Maryland, Abel Wollman discusses briefly an investigation made by the bureau in the matter of flies on trickling filters. His report on the subject is as follows:

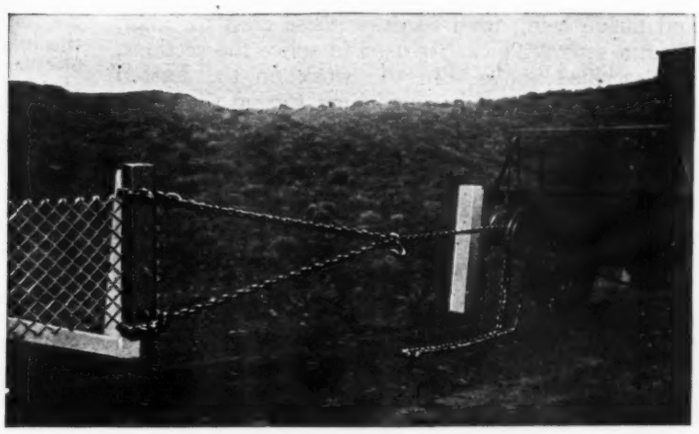
"Frequently trickling filters at sewage treatment works become infested with the gnat known as 'psychoda alternata' which it is difficult to exterminate. Past experience has shown that fortnightly flooding of the filter bed will practically prevent the breeding of the gnat, but as may filters are so constructed as to make flooding impossible, other methods have been tried. The Baltimore city officials arranged with the Baltimore County Metropolitan District to conduct a series of experiments at the Towson sewage treatment plant to determine the effect of the application of chlorine upon the psychoda. A series of experiments, each of which consisted of the application of chlorine to the trickling filter bed for a continuous period of 24 hours, was carried out. As a result of this work, it was found that little, if any, beneficial effect, as far as the extermination of the 'psychola alternata' was concerned, was obtained. The oxidizing efficiency of the trickling filter unit, however, was somewhat impaired temporarily by this treatment."

Erecting a Highway Guard Fence

Many highway boards and departments are using wire fences as guards at dangerous curves and embankments and to these the method employed by the Nevada Department of Highways in erecting such a fence will be interesting. The fence in question consisted of two hundred feet of "Hi-way guard" at the Lassen Volcanic Highway near Reno.

Cedar posts 6x6 inches and 6½ feet long and painted white were set ten feet apart to carry the fence, 3½ feet of the post being buried. The end posts were braced in the ordinary manner with 4x6 braces.

The fencing was delivered on the job in 100-foot rolls, and the first operation was to unroll the material along the right-of-way near the line of posts, to the road side of them. One end of the fabric was attached around the end post by means of ordinary staples. A special clamp consisting of two pieces of wood was bolted to the further end of the section of fencing, attached by chain sling.



WHEELS OF TRUCK BLOCKED AND CHAIN BLOCK STRETCHING FABRIC.

WEAVING IN PICKET TO SPLICE TWO SECTIONS TOGETHER.

to a chain block which was fastened to a corner of the frame of the maintenance truck. The truck was driven ahead until the chains were taut, when the wheels were blocked. The fabric was then stretched by pulling up on the chain block until it was sufficiently tight, when it was fastened to each of the posts by means of staples. The second 100-foot section was then spliced to the end of the first by means of a loose picket twisted through the two ends, the truck and clamp were carried to the further end of the second section and the operation repeated. A temporary brace was placed in front of the last post to which the first section was fastened, to carry the strain until the second section had been stretched and stapled.

Where a truck is not available, an ordinary block and tackle are commonly used, the tackle being anchored to a post. Where sections two hundred feet long or more are being installed, two sections are often stretched at one time, the extreme ends being first fastened to braced posts, a clamp being fastened to each of the two loose ends and the block and tackle being used to draw these ends together, when a separate picket is used to splice the sections, as described above. In the work on the Lassen Highway the entire job, including setting the posts, was done by two men.

English Refuse Disposal Notes

Storage, collection and salvage of house refuse at Eccles. Collection and disposal in 1924. Charging for removing trade refuse.

A number of items concerning refuse disposal in several English cities, condensed from articles appearing recently in English periodicals, have been published by the Bureau of Public Health Service in its Public Health Engineering Abstracts.

House refuse storage and collection at Eccles were described by C. W. Laskey, senior sanitary inspector and cleansing superintendent. His statement is abstracted as follows:

The population is 46,000, occupying 10,623 houses, and there are 10,956 ashbins in use. The ashbins are of galvanized iron and are of standard sizes (24x18 and 18x18 inches), circular in shape and fitted with "weathered" and overlapping lids. They are kept in stock by the Cleansing Department, and supplied to order of house owners. No difficulty has been experienced in collecting charges. The average life of the bins is 11 years. The average cost of collection is 8s. per ton, including fixed charges, the weight of refuse removed (January-September, 1924) averaging 1415 lbs. per 1000 of population per working day.

Further information concerning the Eccles plant was given in an article by G. W. Willis, engineer and manager of the sewage disposal works, Mr. Willis's remarks being condensed in the following paragraph:

A refuse salvage plant has been installed at Eccles to facilitate the operation of the destructor-steam generating plant, difficulty having been experienced in generating sufficient steam for sewage pumping owing to a decrease in the evaporation value of the refuse. Salable material is picked from the refuse, the fine dust and cinders separated, and the remainder destroyed in the destructor. The cinders are used for generating steam in boilers which were in use before the destructor plant was installed. The water evaporation in 1914 by the destructor was equivalent to 0.9 lbs. of water per lb. of refuse, while the evaporation in boilers using cinders screened from the refuse is equivalent to 2.1 lbs. of water per lb. of refuse (5.54 lb. of water per lb. of cinders—10,875 B. T. U. per lb.) In addition to the increased efficiency of the steam plant, salvage operations have decreased the cost of disposal 2s. 10 3/4d. per ton, an annual profit of £975 now being derived from the disposal of refuse.

Two other abstracts are furnished of articles dealing more generally with the subject, one being a review of refuse collection and disposal in 1924, appearing in "The Surveyor"; the other being replies to a questionnaire relative to the removal of trade refuse sent out by J. Leigh Turner, town clerk of Blyth. In the former

"Hope is expressed that the use of destructor clinker in road construction will add impetus to the employment of the destructor process, and the retrogression by some municipalities in returning to the old system of tipping is deplored. The importance of the furtherance of the policy of educating householders regarding the storage of refuse prior to its collection is emphasized. Instruction of elder children in schools along these lines is being adopted in Britain, in addition to the education of the general public by issuance of pamphlets relating to this subject.

The resumé of the replies to Mr. Turner's questionnaire was as follows:

Objections had been received regarding charge for removal of refuse from cinema houses and fish dealers, and this method was adopted for obtaining information upon which to base a decision. Of the 56 authorities replying, 50 undertake the removal of trade refuse, 31 make a charge, 19 made no charge, and 6 do not remove trade refuse. Only 2 of these boroughs collect refuse from fish dealers free of charge, while as regards theatres and cinemas, 31 make a charge while 10 do not. Several legal decisions relative to this problem are quoted.

Improving Earth Roads

The improvement of earth roads is to be the subject of an investigation by the Highway Research Board which is to be national in scope and is to co-ordinate the efforts and data already available concerning the improvement of earth roads and stimulate further research in order to find an inexpensive surface that will carry intermediate traffic at a low cost of both construction and maintenance.

Announcement is made by Charles M. Upham, Director of the Highway Research Board, that Prof. S. S. Steinberg, of the University of Maryland, has been appointed secretary of this investigation.

Prof. Steinberg has had fifteen years of engineering experience, ten of them in highway construction and research, five with the New York State Highway Department and later with the state highway departments of South Carolina and Delaware. During several summers Prof. Steinberg was with the U. S. Bureau of Public Roads on detail at the University of Maryland in connection with highway research being conducted there by Dean Johnson.

Recent Legal Decisions

MUNICIPALITIES AND CONTRACTORS NOT LIABLE FOR INJURY FROM STEAM ROLLERS, ETC., TEMPORARILY LEFT IN HIGHWAY

In an action against a road contractor for injuries caused by plaintiff's horse becoming frightened by the flapping of the curtains covering a steam roller left in the road, the Pennsylvania Supreme Court, Perry v. Thomas Cronin Co., 123 Atl. 771, reversed judgment for plaintiff and entered judgment for defendant, holding that " a municipality or its contractor, in the construction of a highway, may temporarily leave within the bounds thereof material and machinery when necessary, if done with reasonable care, and a finding of negligence against a contractor cannot be sustained from the mere fact of his leaving a steam roller, or other object, standing for a considerable time within the bounds of a highway which is under construction, where, as here, ample room is left for public travel."

INTEREST IN CONTRACT LET ON COMPETITIVE BIDS

The Mississippi Supreme Court holds, Dempsey v. State, 99 So. 5, that, in a prosecution under Chapter 278, Miss. Laws 1922, of a member of the board of supervisors for knowingly voting to let a contract to one of his relatives on competitive bids therefor, the state must prove that such relative was not the lowest responsible bidder.

DAMAGES FOR DELAY UNDER PAVING CONTRACT

A contract for paving six separate areas provided that the contractor should pay the city $20 for every day the work remained uncompleted after the specified time for completion. The Michigan Supreme Court held, Ann Arbor Asphalt Const. Co. v. City of Howell, 198 N. W. 195, that the provision was one for stipulated damages, and not for a penalty, "the damages for delay in constructing the pavement, or any unit of it, being uncertain in their nature and difficult to be ascertained, and the sum provided by contract being no more than compensation for damages of the city and its inhabitants for delay in construction of the pavement as a whole or of any unit of it * * * and this regardless of the fact that the contract is for the performance of several stipulations of different degrees of importance, and one sum is made payable on the breach of any one or of all of them."

CONTRACTS AS TO WATER RATES HELD SUBJECT TO COMMISSIONER'S ORDER

The New Jersey Court of Errors and Appeals holds, Acquakanonk Water Co. v. Board of Public Utility Comrs., 125 Atl. 33, that contracts as to rates between cities and water companies cannot prevail against an order of the board of public utility commissioners.

As against the claim that a recognized exception to the general rule that the state's power to regulate public utility rates cannot be forestalled by contracts between the utilities and their customers, attempting to fix rates in advance for a term of years, exists in favor of municipality contracts made by express authority of the state, fixing rates for a reasonably limited term, the Connecticut Supreme Court of Errors holds, City of Ansonia v. Ansonia Water Co., 125 Atl. 474, that the exception is narrowly confined to cases in which it clearly and unmistakably appears, first, that the state has delegated its rate-regulating power to the municipality, acting within its geographical limits, and, second, that the municipality has equally clearly and certainly exercised its delegated power by a contract fixing the rate to be charged for a limited term.

The Connecticut court says that the cases coming under the exception claimed decided by the United States Supreme Court divide themselves into two classes. First, those in which the state has in its Constitution or by statute explicitly conferred upon the municipality the power to establish by ordinance the rates to be charged by public service corporations operating within its limits. Second, the so-called "franchise contract" cases, in which the municipality, being explicitly authorized to grant franchises conferring upon persons or associations the right to use its streets for laying water pipes, gas pipes, or street railway tracks, has by ordinance, accepted by and acted upon by a public service corporation, granted a franchise specifying the maximum rates to be charged for a given term.

AUTHORITY TO ISSUE BONDS FOR PUBLIC LIBRARIES AND PARKS

The New Mexico Supreme Court holds, Bachechi v. City of Albuquerque, 224 Pac. 400, that under a statutory power to cities to issue bonds to construct public buildings cities have power to issue bonds for the erection of a public library building; but where the statute provides for a bond for the improvement of streets, making no mention of public parks, a city cannot issue bonds for the improvement of its parks on the theory that its park system is a part of the street system.

NECESSITY FOR CONDEMNATION OF PROPERTY DETERMINED BY CITY AUTHORITIES

The Kentucky Court of Appeals holds, First National Bank of Paducah v. City of Paducah, 258 S. W. 938, that the city in carrying out a sewerage improvement program, had the power to condemn and appropriate private property for a right of way for a sewer line although it owned a street running almost parallel with the proposed sewer line that might have been employed for the same purpose. The authority to determine whether the appropriation of lands was for a public use and the necessity of it is held to be vested in the governing authority of the city and not in the courts under Ky. St. §3095.

CITY LIABLE FOR DAMAGE FROM WATER ESCAPING FROM BROKEN MAIN

The Minnesota Supreme Court holds, Bridgeman-Russell Co. v. City of Duluth, 197 N. W. 971, that no distinction can be made between waters escaping in destructive quantities from a broken reservoir and flooding the premises of an adjacent owner, and such waters so escaping from a break in a principal main leading from such reservoir.

EFFECT OF READING IMPROVEMENT ORDINANCE WITHOUT OBJECTION

The New Jersey Court of Errors and Appeals holds, Haake v. Borough of Norwood, 125 Atl. 6, by a divided court, that the reading of an improvement ordinance at a meeting of a borough council, without objection from the members thereof, is a considering of the same, and therefore the action of the council in giving "notice of intention" to undertake the improvement, after such reading, is in violation of the procedure prescribed in section 9 of article 20 of the act concerning municipalites, as amended by New Jersey P. L. 1918, p. 484.

IMPROVEMENT CONTRACT NOT VOID BECAUSE OF ADDED PER CENT TO EQUAL DEPRECIATION OF BONDS BELOW PAR

The Oklahoma Supreme Court holds, City of Pauls Valley v. Carter, 224 Pac. 528, that although it be unlawful under the statute authorizing paving improvements to add to the estimated cost of the improvement a per cent which will equal the depreciated value of the bonds issued in payment of such improvement, yet, where it does not appear from the estimate on file that such per cent was in fact added, and where it does appear that the property owners have filed no protest against such improvement nor taken any action to enjoin the adding of such per cent. to the assessment, and by their failure to act have justified the contractor in assuming that such claim of added per cent. had been abandoned, and where such property owners remained silent and permitted such work to proceed to near completion, and where the proceedings by the city officers have been legal and regular in all other respects, and where such work has been done in satisfactory compliance with the prescribed plans and specifications, and where the bids submitted and contracts awarded were actually for less than the estimated cost, the contractor is entitled to the full value of his contract less the difference between same and the per cent. added for depreciation in market value of the bonds.

MUNICIPALITY MAY CONTRACT FOR PUBLIC SERVICE RATES UNTIL STATE INTERVENES BY LEGISLATION

The New Mexico Supreme Court holds, Town of Gallup v. Gallup Electric Light & Power Co., 225 Pac. 724, that municipalities may make contracts with public service corporations in regard to rates to their inhabitants, not intended by the parties to withstand the subsequent exercise of the governmental power of regulation, which are valid as between the parties until the state elects to intervene and regulate rates. Should the municipality, at the time of the contract, be clothed with the legislative power to regulate rates for part of the service, as for the supply of electric light, and consequently without power to contract away its legislative power, the whole contract is not thereby rendered invalid. The fact that the rate has become non-compensatory and confiscatory is held to be no defense to the enforcement of the contract.

STATUTORY LIMITATION AGAINST INDEBTEDNESS APPLIES TO INVOLUNTARY INDEBTEDNESS

The New Mexico Supreme Court holds, Santa Fé Water & Light Co. v. Santa Fé County, 224 Pac. 402, that the statutory limitation against indebtedness applies to debts contracted for necessities such as water and lights for a courthouse, or other debts which may be arbitrarily placed by law against a county or other municipality with the same force as to those voluntarily created by such county or municipality.

CONSTRUCTION OF CONDITION AS TO REPAIR OF STREET BY STREET RAILWAY COMPANY

In an action by a municipality against a street railway company for reimbursement for money expended in repairing a street, it appeared that the company acquired its right to occupy the street on the stipulation that it would keep it in repair from curb to curb and at all times in good order with telford or macadam. The company contended that the agreement contemplated only horse-drawn vehicular travel, and that the repairs were useless, as a telforded or macadamized road could not bear the strain of the traffic now passing over it. The Pennsylvania Supreme Court held, Borough of Swarthmore v. Philadelphia Rapid Transit Co., 124 Atl. 343, that while it is true that, in construing a contract, and determining the obligation assumed by the parties thereunder, the conditions existing at the time it was entered into must be considered, if there is a specific agreement to do a certain thing this must be complied with, notwithstanding the cost involved is greater than originally considered likely. The use of automobiles, making necessary more extensive outlays, did not relieve the railway company from the responsibility it assumed. Its promise to repair "was a condition precedent to the right of entry, and no matter how often changes may be required the cost thereof must be paid by the street railway, so long as it sees fit to occupy the highway."

VOID CONTRACTS NOT RATIFIED BY ACTS OF CITY OFFICERS

The Missouri Court of Appeals holds, Iowa Bonding & Casualty Co. v. City of Marceline, 255 S. W. 577, that where there was no contract and an attempt to create a contract (the taking out of insurance against public liability and employers' liability) was void and without authority of law, the officers of the city could not by their acts create a contract by ratification, or by anything less formal than is required to constitute a contract under the Missouri statute.